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**PTHISTRY: A Code for Predicting
Long-term Pressure-Temperature History in
Secondary Containment of Water-cooled Reactors
Following Accident-induced Blowdown**

by

Bryant N. Kristianson

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Reactor Engineering Division

May 1968

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NOMENCLATURE

Symbol	Description	Units	Symbol	Description	Units	Symbol	Description	Units
$\frac{1}{13}$	Air inventory at start of time interval.	lb	$(\frac{k}{\Delta x})_{n-1+n}$	Conductivity and distance parameter between $n-1$ node and n th node.	Btu/(hr K 2 ft 2)	E_{12}^2	Decay heat energy transferred directly to water on lower floor during time interval.	Btu
c	Specific heat.	Btu/(lb K $^{\circ}$ F)	$(\frac{k}{\Delta x})_s$	Conductivity and distance parameter between a surface node and adjacent interior node.	Btu/(hr K 2 ft 2)	E_{13}^2	Decay heat energy transferred directly to containment atmosphere during time interval.	Btu
c_v	Specific heat at constant volume.	Btu/(lb K $^{\circ}$ F)	$(pc \frac{\Delta x}{2})_{n-1+n}$	Heat storage parameter of the half-thickness toward a $(n-1)$ node associated with the n th node.	Btu/(ft 2 K $^{\circ}$ F)	H_{10}^2	Heat energy removed directly from pool water during time interval.	Btu
c_{va}	Specific heat of air at constant volume.	Btu/(lb K $^{\circ}$ F)	$(pc \frac{\Delta x}{2})_{n-1+n}$	Heat storage parameter of the half-thickness toward a $(n+1)$ node associated with the n th node.	Btu/(ft 2 K $^{\circ}$ F)	H_{11}^2	Heat energy removed directly from water on upper floor during time interval.	Btu
h	Convective heat transfer coefficient.	Btu/(hr K 2 ft 2)	$(pc \frac{\Delta x}{2})_s$	Heat storage parameter of the half-thickness on a surface associated with the surface node.	Btu/(ft 2 K $^{\circ}$ F)	H_{12}^2	Heat energy removed directly from water on lower floor during time interval.	Btu
h_{10-9}	Convective heat transfer coefficient between pool water and pool container.	Btu/(hr K 2 ft 2)	A	Solid subsystem surface area.	ft 2	H_{13}^2	Heat energy removed directly from containment atmosphere during time interval.	Btu
h_{11-8}	Convective heat transfer coefficient between water on upper floor and upper floor structure.	Btu/(hr K 2 ft 2)	A_e	Water evaporation area.	ft 2	P_a	Containment air partial pressure.	psia
h_{12-7}	Convective heat transfer coefficient between water on lower floor and lower floor structure.	Btu/(hr K 2 ft 2)	A_{10-9}	Effective area for convective heat transfer between pool water and pool container.	ft 2	P_{sv}^2	Computed saturated water vapor pressure at average water temperature during time interval.	psia
h_{13-1}	Convective heat transfer coefficient between containment atmosphere and dome.	Btu/(hr K 2 ft 2)	A_{11-8}	Effective area for convective heat transfer between water on upper floor and upper floor structure.	ft 2	P_y	Containment water vapor partial pressure.	psia
h_{13-2}	Convective heat transfer coefficient between containment atmosphere and wall above grade.	Btu/(hr K 2 ft 2)	A_{12-7}	Effective area for convective heat transfer between water on lower floor and lower floor structure.	ft 2	P_v^2	Computed vapor pressure at average air temperature and average water vapor inventory during time interval.	psia
h_{13-3}	Convective heat transfer coefficient between containment atmosphere and wall below grade.	Btu/(hr K 2 ft 2)	A_{13-1}	Effective area for convective heat transfer from the dome.	ft 2	P_+	Containment overpressure.	psia
h_{13-4}	Convective heat transfer coefficient between containment atmosphere and metal internal structures.	Btu/(hr K 2 ft 2)	A_{13-2}	Effective area for convective heat transfer from the wall above grade.	ft 2	Q_{tf}	Total heat flow into subsystem Z .	Btu
h_{13-5}	Convective heat transfer coefficient between containment atmosphere and concrete internal structures.	Btu/(hr K 2 ft 2)	A_{13-3}	Effective area for convective heat transfer between wall below grade and containment atmosphere.	ft 2	Q_{10-r}^2	Heat removed directly by refrigeration from pool water during time interval.	Btu
h_{13-6}	Convective heat transfer coefficient between containment atmosphere and lower floor not covered by water.	Btu/(hr K 2 ft 2)	A_{13-4}	Effective area for convective heat transfer between containment atmosphere and metal internal structures.	ft 2	Q_{10-9}^2	Heat transferred by convection from pool water to pool container during time interval.	Btu
h_{13-8}	Convective heat transfer coefficient between containment atmosphere and bottom side of upper floor covered by water.	Btu/(hr K 2 ft 2)	A_{13-5}	Effective area for convective heat transfer between containment atmosphere and pool container.	ft 2	Q_{11-r}^2	Heat removed directly by refrigeration from water on upper floor during time interval.	Btu
h_{13-9}	Convective heat transfer coefficient between containment atmosphere and pool container.	Btu/(hr K 2 ft 2)	A_{13-6}	Effective area for convective heat transfer between containment atmosphere and concrete internal structures.	ft 2	Q_{11-8}^2	Heat transferred by convection from water on upper floor to upper floor structure during time interval.	Btu
h_{13-10}	Convective heat transfer coefficient between containment atmosphere and pool water.	Btu/(hr K 2 ft 2)	A_{13-8}	Effective area for convective heat transfer between containment atmosphere and lower floor not covered by water.	ft 2	Q_{12-r}^2	Heat removed directly by refrigeration from water on lower floor during time interval.	Btu
h_{13-11}	Convective heat transfer coefficient between containment atmosphere and water on upper floor.	Btu/(hr K 2 ft 2)	A_{13-9}	Effective area for convective heat transfer between containment atmosphere and bottom of upper floor structure.	ft 2	Q_{12-7}^2	Heat transferred by convection from water on lower floor to lower floor structure during time interval.	Btu
h_{13-12}	Convective heat transfer coefficient between containment atmosphere and water on lower floor.	Btu/(hr K 2 ft 2)	A_{13-10}	Effective area for convective heat transfer between containment atmosphere and pool water.	ft 2	Q_{13-r}^2	Heat removed directly by refrigeration from containment atmosphere during time interval.	Btu
k	Thermal conductivity.	Btu/(hr K 2 ft 2)	A_{13-11}	Effective area for convective heat transfer between containment atmosphere and water on upper floor.	ft 2	Q_{13-1}^2	Heat transferred by convection from containment atmosphere to done during time interval.	Btu
t_0	Reactor operating time at full power.	sec	A_{13-12}	Effective area for convective heat transfer between containment atmosphere and water on lower floor.	ft 2	Q_{13-2}^2	Heat transferred by convection from containment atmosphere to wall above grade during time interval.	Btu
t_s	Time after shutdown.	sec	E_{12}	Initial internal energy of subsystem Z .	Btu	Q_{13-3}^2	Heat transferred by convection from containment atmosphere to wall below grade during time interval.	Btu
w_e	Evaporation rate for water.	lb/hr	A_{13-11}	Final internal energy of subsystem Z .	Btu	Q_{13-4}^2	Heat transferred by convection from containment atmosphere to metal internal structures during time interval.	Btu
β	Delayed neutron fraction.	none	E_{12}	Decay heat energy transferred directly to pool water during time interval.	Btu	Q_{13-5}^2	Heat transferred by convection from containment atmosphere to concrete internal structures during time interval.	Btu
Δt	Time interval.	sec	E_{10}^2	Decay heat energy transferred directly to water on upper floor during time interval.	Btu	Q_{13-6}^2	Heat transferred by convection from containment atmosphere to lower floor not covered by water during time interval.	Btu
Δx	Sum of the two half-intervals on each side of a node in a solid subsystem.	ft	E_{11}^2	Decay heat energy transferred directly to water on lower floor during time interval.	Btu			
$\Delta x/2$	Half-interval adjacent to a node in a solid subsystem.	ft						
ϵ	Convergence criterion.	none						
λ	Decay constant of delayed neutron precursor.	sec $^{-1}$						
μ	Fractional leakage rate from containment building.	sec $^{-1}$						
ρ	Step change in reactivity; material density.	#/lb ft 3						
$(\frac{k}{\Delta x})_{n-1+n}$	Conductivity and distance parameter between $(n-1)$ node and n th node.	Btu/(hr K 2 ft 2)						

NOMENCLATURE (Contd.)

Symbol	Description	Units	Symbol	Description	Units	Symbol	Description	Units
Q_{13-8}^2	Heat transferred by convection from containment atmosphere to bottom of upper floor structure covered by water during time interval.	Btu	T_{n+1}^3	Temperature of ($n+1$) interior node at end of time interval.	°F	U_{10}^2	Internal energy of pool water at average containment atmosphere temperature during time interval.	Btu/lb
Q_{13-9}^2	Heat transferred by convection from containment atmosphere to pool container during time interval.	Btu	T_{058}	Outer surface temperature of upper floor structure.	°F	U_{10}^3	Internal energy of the pool water at end of time interval.	Btu/lb
Q_{13-10}^2	Heat transferred by convection from containment atmosphere to pool water during time interval.	Btu	T_{059}	Outer surface temperature of pool container.	°F	U_{11}^1	Internal energy of water on upper floor at start of time interval.	Btu/lb
Q_{13-11}^2	Heat transferred by convection from containment atmosphere to water on upper floor during time interval.	Btu	T_s^1	Surface temperature of solid subsystem at start of time interval.	°F	U_{11}^2	Internal energy of water on upper floor at average containment atmosphere temperature during time interval.	Btu/lb
Q_{13-12}^2	Heat transferred by convection from containment atmosphere to water on lower floor during time interval.	Btu	T_{sn}^3	Surface temperature of solid subsystem at end of time interval.	°F	U_{11}^3	Internal energy of water on upper floor at end of time interval.	Btu/lb
R_{fp}	Reactor decay power due to heat emission from fission products.	MW	T_{s5}	Temperature of solid subsystem at node adjacent to surface node at start of time interval.	°F	U_{12}^1	Internal energy of water on lower floor at start of time interval.	Btu/lb
R_0	Reactor operating power.	MW	T_{s5}	Temperature of solid subsystem at node adjacent to surface node at end of time interval.	°F	U_{12}^2	Internal energy of water on lower floor at average containment atmosphere temperature during time interval.	Btu/lb
R_{rf}	Reactor decay power due to residual fission after shutdown.	MW	T_{10}	Surface temperature of metal internal structures.	°F	U_{12}^3	Internal energy of water on lower floor at end of time interval.	Btu/lb
T_1	Temperature at start of time interval.	°F	T_{11}	Surface temperature of concrete internal structures.	°F	W_{c10}^2	Total free volume of containment atmosphere.	ft ³
T_3	Temperature at end of time interval.	°F	T_{12}	Temperature of water on upper floor.	°F	W_{c11}^2	Amount of water vapor condensed which mixes with pool water during time interval.	lb
T_8	Containment atmosphere temperature	°F	T_{13}	Containment atmosphere temperature.	°F	W_{c12}^2	Amount of water vapor condensed which mixes with water on upper floor during time interval.	lb
T_9^1	Temperature of gas (or liquid) next to surface of solid subsystem at start of time interval.	°F	U_1^1	Internal energy at start of time interval.	Btu/lb	W_{e10}^2	Amount of water vapor condensed which mixes with water on lower floor during time interval.	lb
T_9^3	Temperature of gas (or liquid) next to surface of solid subsystem at end of time interval.	°F	U_3^3	Internal energy at the end of time interval.	Btu/lb	W_{e11}^2	Amount of pool water evaporated during time interval.	lb
T_{i-1}	Temperature determined by $i-1$ iteration.	°F	U_{sw}^1	Internal energy of spray water at start of time interval.	Btu/lb	W_{e12}^2	Amount of water evaporated from upper floor during time interval.	lb
T_{is1}	Inner surface temperature of done.	°F	U_{sw}^3	Internal energy of spray water at end of time interval.	Btu/lb	W_s^2	Amount of water sprayed during time interval.	lb
T_{is2}	Inner surface temperature of wall above grade.	°F	U_{v10}^2	Internal energy of water vapor at average pool water temperature during time interval.	Btu/lb	W_{s11}^2	Amount of water sprayed which mixes with water on upper floor during time interval.	lb
T_{is3}	Inner surface temperature of wall below grade.	°F	U_{v11}^2	Internal energy of water vapor at average temperature of water on upper floor during time interval.	Btu/lb	W_{s12}^2	Amount of water sprayed which mixes with water on lower floor during time interval.	lb
T_{is6}	Inner surface temperature of lower floor not covered by water.	°F	U_{v12}^2	Internal energy of water vapor at average temperature of water on lower floor during time interval.	Btu/lb	W_{v13}^1	Inventory of water vapor at start of time interval.	lb
T_{is7}	Inner surface temperature of lower floor covered by water.	°F	U_{v12}^2	Internal energy of water vapor at start of time interval.	Btu/lb	W_{vc}^2	Amount of water vapor condensed during time interval.	lb
T_{is8}	Inner surface temperature of upper floor structure covered by spilled water.	°F	U_{v13}^1	Internal energy of water vapor at average containment atmosphere temperature during time interval.	Btu/lb	W_{10}^1	Inventory of pool water at start of time interval.	lb
T_{is9}	Inner surface temperature of pool container.	°F	U_{v13}^1	Internal energy of water vapor at end of time interval.	Btu/lb	W_{11}^1	Inventory of water on upper floor at start of time interval.	lb
T_n^1	Temperature of n th interior node at start of time interval.	°F	U_{v13}^2	Internal energy of water vapor at average containment atmosphere temperature during time interval.	Btu/lb	W_{12}^1	Inventory of water on lower floor at start of time interval.	lb
T_n^3	Temperature of n th interior node at end of time interval.	°F	U_{v13}^3	Internal energy of water vapor at end of time interval.	Btu/lb	W_E	Work done by subsystem E.	Btu
T_{n-1}^1	Temperature of ($n-1$) interior node at start of time interval.	°F	U_w^2	Internal energy of water at average containment atmosphere temperature during time interval.	Btu/lb			
T_{n-1}^3	Temperature of ($n-1$) interior node at end of time interval.	°F	U_w^1	Internal energy of pool water at start of time interval.	Btu/lb			
T_{n+1}^1	Temperature of ($n+1$) interior node at start of time interval.	°F	U_{10}^1					

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ABSTRACT

Written in FORTRAN 63 for the CDC-3600 computer, the PTHISTRY Code (ANL designation: RE-360X) solves a series of heat balance equations. These equations give a time-dependent description of the pressure and temperatures inside the secondary containment after a postulated water expulsion blowdown accident of the reactor primary system. Included are the input specifications, a sample problem, and a FORTRAN listing of the code.

I. INTRODUCTION

Use of secondary containment structures for water-cooled reactors, whether for basic research or for large, central station power plants, is well established by convention and precedent in the United States. The design characteristics of these structures (pressure, temperature, volume, configuration, materials, allowable leakage rate) are determined by an analysis of potential hazards associated with normal operation of the specific facility, the consequences of postulated credible accidents, and the system safeguards incorporated to preclude or minimize their occurrence. In all instances, the secondary containment is designed to ensure that accident-induced rupture of primary system integrity will not result in uncontrolled release of harmful fission products (e.g., $I^{131-135}$, Sr^{90} , and Ce^{144}) to the surrounding environment.

In the ideal case, the gage pressure inside the secondary containment would be maintained at zero or a slightly negative value (relative to the outside atmospheric pressure) to prevent such outleakage. However, coincident with or following rupture of the primary system containment is the possible release of stored energy from the system, and of decay and fission heat from the reactor. If normal heat removal systems are rendered inoperative by the accident, this energy (heat) release could lead to a pressure and temperature increase and consequent breaching of the secondary

containment. Thus, a method for computing the postaccident pressure-temperature history is essential to a comprehensive analysis of the secondary containment design.

This report describes a computer code to facilitate such an analysis. Appropriately entitled PTHISTRY and written in FORTRAN 63 for a CDC-3600 computer, the code solves a series of heat balance equations to give a time-dependent description of the pressure and temperatures inside the secondary containment following a postulated water-expulsion blowdown accident in a water-cooled and -moderated reactor.

The code was developed for use in the design and safety analysis of the secondary containment of the Argonne Advanced Research Reactor (AARR).¹ At design operating conditions, the primary system water temperature in this reactor would not have exceeded the boiling point at normal atmospheric pressure. Thus the blowdown accompanying a water expulsion accident in AARR would not result in a large, rapid pressure buildup inside the secondary containment, as might occur in large power reactors operating with much higher water temperatures. Hence, the code, as developed for the AARR system, is meant to be used only to determine the long-term (minutes to days) pressure-temperature history after the short-term blowdown phase has been completed.

Although developed specifically for use on the AARR system, the PTHISTRY Code possibly can be used in the analysis of other water-cooled reactor systems. To facilitate such use, this report contains a detailed description of the pertinent system and subsystem heat balance equations, the computer input specifications, a sample problem, and a FORTRAN listing of the Code.

II. SYSTEM DESCRIPTION

The system to be analyzed may comprise some or all of the solid, liquid, and gaseous subsystems enumerated below and shown schematically in Fig. 1. Starting with Fig. 1, the enumeration is used as subscripts to identify subsystem parameters, energy storage and transfers in equations, tables, and illustrations throughout the balance of this report.

- (1) Dome.
- (2) Wall above grade.
- (3) Wall below grade.
- (4) Metal internal structures. *
- (5) Concrete internal structures.

- (6) Lower floor and foundation structure not covered by spilled water.
- (7) Lower floor and foundation structure covered by spilled water.
- (8) Upper floor structure covered by spilled water.
- (9) Pool water container.
- (10) Pool water.
- (11) Spilled water on upper floor.
- (12) Spilled water on lower floor.
- (13) Contained air/water vapor.

ATMOSPHERIC ENVIRONMENT

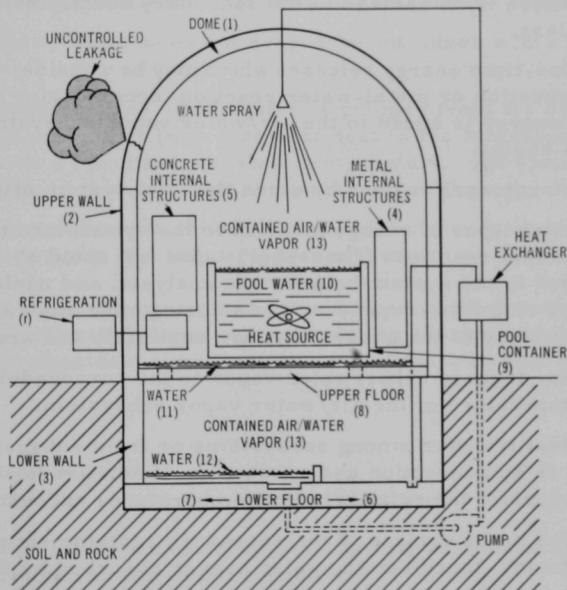


Fig. 1. Subsystems, Surroundings, and Corresponding Nomenclature
(in parentheses) Used in Analysis of Secondary Containment.

The reactor core is considered a heat source and not a subsystem. Any apparatus which aids heat transfer from the system to the surroundings is considered a heat sink and not a subsystem. Such an apparatus might be a refrigeration unit, a recirculating, cooled water-spray system, or a heat exchanger.

System surroundings include the atmospheric environment and the soil or rock into which the containment structure is built.

III. ANALYTICAL DEVELOPMENT

A. Conditions and Assumptions

The analysis follows ground rules which provide simplifications, where necessary, that permit a numerical solution. More specifically:

- (1) The boundaries of all subsystems, hence the entire system, remain constant.
- (2) The analysis begins after primary blowdown under adiabatic conditions. There is no damage to the secondary containment which would render it useless.
- (3) One-time energy releases which may be considered, such as hydrogen combustion or metal-water reaction, occur during blowdown and the resulting energy is added to the air/water vapor subsystem before code analysis begins.
- (4) No net work is done by or on the total system after the accident.
- (5) Most types of energy addition to the system are considered, including chemical reactions ("one-shot" types as noted above) whose energy is added to the system before code analysis, and nuclear after-heat which is added on a time-dependent basis during code analysis. Kinetic and potential energy of the subsystems are negligible and are neglected.
- (6) Any leakage of air/water vapor to the surroundings occurs at a constant temperature of the air/water vapor subsystem.
- (7) Heat transfer among subsystems or from subsystems to the surroundings is by convection and conduction. Radiative heat transfer is neglected because of the relatively low temperatures encountered.
- (8) The outer surface of the secondary containment structure is a perfect reflector; therefore, no solar heat is absorbed by the structure.
- (9) The surroundings remain at a constant temperature and pressure.
- (10) Initial states of all subsystems are known.
- (11) Heat is transferred by unspecified means directly from the reactor core to any subsystem or subsystems designated to receive it.
- (12) No temperature gradients exist in the gaseous or liquid subsystems.
- (13) No contact resistances exist between distinct layers of the solid subsystems.

(14) Heat conduction in the solid subsystems is one-dimensional.

(15) Gaseous and liquid subsystems are separate, homogeneous mixtures.

(16) The perfect gas law is used to describe the state of the air/water vapor subsystem.

(17) Specific heat of dry air in the air/water vapor subsystem is a function of the subsystem temperature.

(18) Specific heats of solid materials in the subsystems are material-dependent constants invariant with temperature.

(19) Various heat transfer coefficients are assigned constant values invariant with temperature.

(20) Water subsystems are treated as saturated liquids.

(21) Spray water does not evaporate but mixes with other water in the system.

(22) Recirculating spray water is pumped from the system water, through a heat exchanger (which rejects heat to the atmosphere) and back to the system at a specified, constant temperature. All spray water attains the temperature of the contained air/water vapor through which it passes.

(23) Heat release and heat transfer are time-dependent; therefore, consequent pressures and temperatures also are time-dependent.

Under these conditions and assumptions, the internal energy (heat) balance among all subsystems and between the system and its surroundings during each postaccident time interval can be described by the general equation:

$$E_{il} + \sum_l (Q_{tl} - W_l) = E_{fl} \quad (1)$$

Equation (1) is expanded in the following section which contains detailed heat balances for each subsystem.²⁻⁵

B. Subsystem Heat Balances

1. Gaseous Subsystem

a. Contained Air/Water Vapor

The detailed heat balance for this subsystem contains many terms because the subsystem communicates directly with all other subsystems except that part of the lower floor and foundation covered by spilled water. It does not communicate directly with the atmospheric environment.

$$\begin{aligned}
& \left(a_{13}^1 U_{a13}^1 + W_{V13}^1 U_{V13}^1 + W_{e11}^2 U_{V11}^2 + W_{e12}^2 U_{V12}^2 + W_{e10}^2 U_{V10}^2 + W_{vc}^2 U_{V13}^2 + W_s^2 U_{sw}^1 \right) \\
& - \left(Q_{13 \rightarrow 1}^2 + Q_{13 \rightarrow 2}^2 \dots + Q_{13 \rightarrow 6}^2 + Q_{13 \rightarrow 8}^2 + Q_{13 \rightarrow 9}^2 \dots Q_{13 \rightarrow 12}^2 + Q_{13 \rightarrow r}^2 + Q_{13 \rightarrow sw}^2 \right) \\
& + \left(E_{13}^2 - H_{13}^2 \right) + \left[\left(W_{e11}^2 + W_{e12}^2 + W_{e10}^2 + W_{vc}^2 \right) \left(\frac{144 P_v^2}{778.2} \right) \left(\frac{V}{W_{V13}^1} \right) \right] \\
& = \left[a_{13}^1 U_{a13}^3 + \left(W_{V13}^1 + W_{e11}^2 + W_{e12}^2 + W_{e10}^2 \right) U_{V13}^3 + W_{vc}^2 U_w^2 + W_s^2 U_{sw}^3 \right]
\end{aligned} \tag{2}$$

Equation (2) indicates that the initial, total internal energy of the contained air/water vapor subsystem includes the total internal energy of:

- (1) the dry air at an initial temperature;
- (2) the water vapor initially present at the same initial temperature as the dry air;
- (3) the additional water vapor that evaporates from the spilled water and pool water subsystems during the time interval, with evaluation at the final temperatures of these subsystems;
- (4) the water vapor, at the initial temperature of the dry air, which condenses during the time interval; and
- (5) the spray water at its initial temperature.

In addition to the heat source and sink (possibly decay heat and refrigeration, respectively), heat is received directly from or given directly to all liquid and solid subsystems except that part of the lower floor covered by spilled water. Mechanical work is done by this subsystem on the liquid subsystems (water vapor condensation) or, conversely, has mechanical work done on it by these subsystems (water evaporation).

The total internal energy of the contained air/water vapor subsystem at the end of the time interval includes the total internal energy of:

- (1) the dry air at its final temperature;
- (2) the water vapor finally present at the final temperature of the dry air;
- (3) the condensed water at the final temperature of the dry air; and
- (4) the spray water at the final temperature of the dry air (assumed).

2. Liquid Subsystems

a. Spilled Water on Upper Floor

This subsystem communicates directly with the contained air/water vapor and upper floor subsystems only.

$$\begin{aligned}
 & [(W_{11}^1 - W_{e11}^2) U_{11}^1 + W_{e11}^2 U_{11}^1 + W_{c11}^2 U_{11}^2 + W_{s11}^2 U_{sw}^1] \\
 & + (Q_{13 \rightarrow 11}^2 - Q_{11 \rightarrow 8}^2 - Q_{11 \rightarrow r}^2) + (E_{11}^2 - H_{11}^2) \\
 & + \left[(W_{c11}^2 - W_{e11}^2) \left(\frac{144 P_v^2}{788.2} \right) \left(\frac{V}{W_{v13}^1} \right) \right] \\
 = & [(W_{11}^1 + W_{s11}^2 - W_{e11}^2) U_{11}^3 + W_{e11}^2 U_{v11}^2] \quad (3)
 \end{aligned}$$

The initial total internal energy of this subsystem comprises that of the spilled water present at its initial temperature and the water vapor condensate and spray water which find their way to this subsystem at the final temperature of the air/water vapor subsystem.

During the time interval, net heat gained by the subsystem comes from any heat source present, from the air/water vapor subsystem, and from the upper floor structure with which it is in contact. Heat loss may occur to any heat sink present in the subsystem. (NOTE: A heat "loss" may actually be a heat gain, if the sign of the quantity of heat transferred is negative.) Mechanical work is done on this subsystem by the air/water vapor subsystem (water vapor condensation) and by the subsystem on the air/water vapor subsystem (water evaporation).

The final total internal energy of the subsystem is contained in the spilled water present and in the water evaporated from this subsystem at the final subsystem temperature.

b. Spilled Water on Lower Floor

This subsystem communicates directly with the contained air/water vapor and the lower floor subsystems.

$$\begin{aligned}
 & [(W_{12}^1 - W_{e12}^2) U_{12}^1 + W_{e12}^2 U_{12}^1 + W_{c12}^2 U_{12}^2 + W_{s12}^2 U_{sw}^1] \\
 & + (Q_{13 \rightarrow 12}^2 - Q_{12 \rightarrow 7}^2 - Q_{12 \rightarrow r}^2) + (E_{12}^2 - H_{12}^2) \\
 & + \left[(W_{c12}^2 - W_{e12}^2) \left(\frac{144 P_v^2}{778.2} \right) \left(\frac{V}{W_{v13}^1} \right) \right] \\
 = & [(W_{12}^1 + W_{s12}^2 - W_{e12}^2) U_{12}^3 + W_{e12}^2 U_{v12}^2] \quad (4)
 \end{aligned}$$

c. Pool Water

This subsystem communicates directly with the contained air/water vapor and the pool water container subsystems.

$$\begin{aligned}
 & \left[(W_{10}^1 - W_{e10}^2) U_{10}^1 + W_{e10}^2 U_{10}^1 + W_{c10}^2 U_{10}^2 \right] \\
 & + \left(Q_{13 \rightarrow 10}^2 - Q_{10 \rightarrow 9}^2 - Q_{10 \rightarrow r}^2 \right) + \left(E_{10}^2 - H_{10}^2 \right) \\
 & + \left[\left(W_{c10}^2 - W_{e10}^2 \right) \left(\frac{144P_v^2}{778.2} \right) \left(\frac{V}{W_{v13}^1} \right) \right] \\
 & = \left[\left(W_{10}^1 - W_{e10}^2 \right) U_{10}^3 + W_{e10}^2 U_{v10}^2 \right] \quad (5)
 \end{aligned}$$

3. Heat Transfer: Gaseous and Liquid Subsystems

The various amounts of heat transferred during any time interval, as shown in Eqs. (2) to (5), are determined according to the following relationships:

$$Q_{13 \rightarrow 1}^2 = h_{13 \rightarrow 1} A_{13 \rightarrow 1} (T_{13} - T_{is1}) \Delta t \quad (6)$$

$$Q_{13 \rightarrow 2}^2 = h_{13 \rightarrow 2} A_{13 \rightarrow 2} (T_{13} - T_{is2}) \Delta t \quad (7)$$

$$Q_{13 \rightarrow 3}^2 = h_{13 \rightarrow 3} A_{13 \rightarrow 3} (T_{13} - T_{is3}) \Delta t \quad (8)$$

$$Q_{13 \rightarrow 4}^2 = h_{13 \rightarrow 4} A_{13 \rightarrow 4} (T_{13} - T_{s4}) \Delta t \quad (9)$$

$$Q_{13 \rightarrow 5}^2 = h_{13 \rightarrow 5} A_{13 \rightarrow 5} (T_{13} - T_{s5}) \Delta t \quad (10)$$

$$Q_{13 \rightarrow 6}^2 = h_{13 \rightarrow 6} A_{13 \rightarrow 6} (T_{13} - T_{is6}) \Delta t \quad (11)$$

$$Q_{13 \rightarrow 8}^2 = h_{13 \rightarrow 8} A_{13 \rightarrow 8} (T_{13} - T_{os8}) \Delta t \quad (12)$$

$$Q_{13 \rightarrow 9}^2 = h_{13 \rightarrow 9} A_{13 \rightarrow 9} (T_{13} - T_{os9}) \Delta t \quad (13)$$

$$Q_{13 \rightarrow 10}^2 = h_{13 \rightarrow 10} A_{13 \rightarrow 10} (T_{13} - T_{10}) \Delta t \quad (14)$$

$$Q_{13 \rightarrow 11}^2 = h_{13 \rightarrow 11} A_{13 \rightarrow 11} (T_{13} - T_{11}) \Delta t \quad (15)$$

$$Q_{13 \rightarrow 12}^2 = h_{13 \rightarrow 12} A_{13 \rightarrow 12} (T_{13} - T_{12}) \Delta t \quad (16)$$

$$Q_{12 \rightarrow 7}^2 = h_{12 \rightarrow 7} A_{12 \rightarrow 7} (T_{12} - T_{is7}) \Delta t \quad (17)$$

$$Q_{11 \rightarrow 8}^2 = h_{11 \rightarrow 8} A_{11 \rightarrow 8} (T_{11} - T_{is8}) \Delta t \quad (18)$$

$$Q_{10 \rightarrow 9}^2 = h_{10 \rightarrow 9} A_{10 \rightarrow 9} (T_{10} - T_{is9}) \Delta t \quad (19)$$

4. Solid Subsystems

There are nine solid subsystems which are assumed to conduct heat in one dimension only. These subsystems are identified in Fig. 2, along with the heat flow scheme (arrows) used in the calculations.

Each subsystem is composed of no more than five homogeneous layers (not necessarily of equal thickness), with a node on each free surface and at each interface between layers. Other nodes may be equally spaced within each layer, but there can be no more than 25 nodes in each subsystem. Figure 3 is a section of a solid subsystem showing the node configuration and indicating homogeneous, constant material properties in each layer. It is assumed there is no contact resistance between layers; however, if needed, such resistance can be simulated by substituting a very thin layer of low-conductivity material for one of the homogeneous layers.

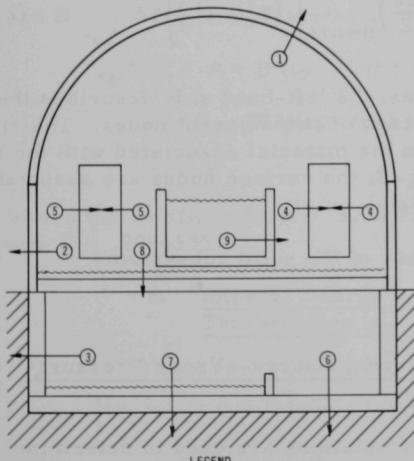


Fig. 2. Solid Subsystems and Heat Flow Scheme Used in Analysis.

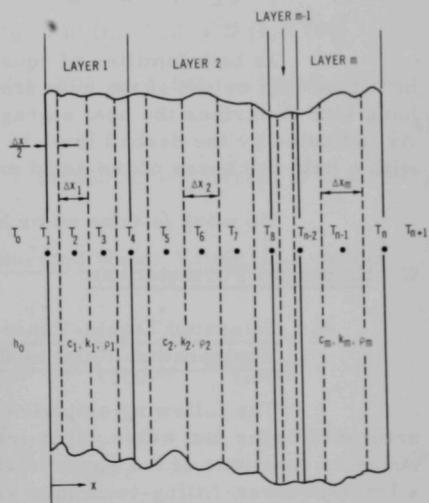


Fig. 3. Section of One-dimensional Heat Conduction Model Used for Solid Subsystems.

The heat balance for the nodes of the solid subsystems is described by two families of equations: one for the surface nodes, and the other for the interior nodes. For the surface nodes, the family of heat balance equations must include convection effects and thus takes the form:

$$\left\{ h \left[\frac{1}{2} (T_g^1 + T_g^3) - \frac{1}{2} (T_s^1 + T_s^3) \right] \Delta t + \left(\frac{k}{\Delta x} \right)_s \left[\frac{1}{2} (T_{sn}^1 + T_{sn}^3) - \frac{1}{2} (T_s^1 + T_s^3) \right] \Delta t \right\} A = \left[\left(\rho c \frac{\Delta x}{2} \right)_s (T_s^3 - T_s^1) \right] A \quad (20)$$

For the interior nodes, the family of heat balance equations does not include convection effects and thus takes the form:

$$\begin{aligned} & \left\{ \left(\frac{k}{\Delta x} \right)_{n-1 \rightarrow n} \left[\frac{1}{2} (T_{n-1}^1 + T_{n-1}^3) - \frac{1}{2} (T_n^1 + T_n^3) \right] \Delta t \right. \\ & \left. + \left(\frac{k}{\Delta x} \right)_{n \rightarrow n+1} \left[\frac{1}{2} (T_{n+1}^1 + T_{n+1}^3) - \frac{1}{2} (T_n^1 + T_n^3) \right] \Delta t \right\} A \\ & = \left\{ \left[\left(\rho c \frac{\Delta x}{2} \right)_{n-1 \rightarrow n} + \left(\rho c \frac{\Delta x}{2} \right)_{n \rightarrow n+1} \right] (T_n^3 - T_n^1) \right\} A \end{aligned} \quad (21)$$

In both families of equations, the left-hand side describes the heat flow into or out of the node from each of two adjacent nodes. The right-hand side describes the heat storage in the material associated with the node. As indicated by the dashed lines in Fig. 3, the surface nodes are associated with a half-thickness of the solid material.

No work is done on or by any of the solid subsystems.

C. Empirical Formulations

1. Saturated Liquid-Vapor Internal Energy--Vapor Pressure-Temperature Relationships

The following empirical formulations are used to determine saturated water and water vapor internal energies and saturated vapor pressures as functions of the appropriate temperatures. They were obtained by a least-squares-fitting-technique and, in some cases, by an interpolation method applied to tabulated handbook values.⁶

a. Saturated Vapor Pressure (p_s) versus Vapor Temperature (t_v)

$$p_s(t_v) = A + B \left(\frac{t_v}{100} \right) + C \left(\frac{t_v}{100} \right)^2 + D \left(\frac{t_v}{100} \right)^3 \\ + E \left(\frac{t_v}{100} \right)^4 + F \left(\frac{t_v}{100} \right)^5 + G \left(\frac{t_v}{100} \right)^6 \quad (22)$$

where for

32.00-85.50°F,	A = .024175;	B = .084653;	C = .27035;	D = .21953;	E = .17970;	F = .17087;	G = -0-
85.50-139.50°F,	+ .011932	+ .20936	+ -.026037	+ .43959	+ .24172	+ .021641	+ .050932
139.50-193.50°F,	+ -.011874	+ .44859	+ -.54257	+ 1.0212	+ -.21385	+ .25200	+ -0-
193.50-295.00°F,	+ 4.2320	+ 6.8874	+ -3.1724	+ .50128	+ .37939	+ .14351	+ -0-
295.00-407.50°F,	+ -14.573	+ 19.596	+ -7.3919	+ .020794	+ .86241	+ .077800	+ -0-
407.50-680.00°F,	+ 280.55	+ -149.55	+ 14.807	+ 1.4145	+ 1.0262	+ -.071390	+ .011703

For temperatures in the range 680-700°F:

$$p_s(t_v) = A + B(t_v - 680) + C(t_v - 680)(t_v - 685) + D(t_v - 680)$$

$$(t_v - 685)(t_v - 690) + E(t_v - 680)(t_v - 685)(t_v - 690)(t_v - 695) \quad (23)$$

where the coefficients A = 2708.1; B = 18.420; C = .056000; D = .00013333; and E = 0. For temperatures in the range 700.00-705.40°F:

$$p_s(t_v) = A + B(t_v - 700) + C(t_v - 700)(t_v - 702) + D(t_v - 700)$$

$$(t_v - 702)(t_v - 704) + E(t_v - 700)(t_v - 702)(t_v - 704)(t_v - 705) \quad (24)$$

where the coefficients A = 3093.7; B = 20.600; C = 0.07500; D = -.0083333; and E = .0094538.

b. Internal Energy of Saturated Water Vapor (U_v) versus Temperature (t_v)

$$U_v(t_v) = A + B \left(\frac{t_v}{100} \right) + C \left(\frac{t_v}{100} \right)^2 + D \left(\frac{t_v}{100} \right)^3 + E \left(\frac{t_v}{100} \right)^4 \\ + F \left(\frac{t_v}{100} \right)^5 + G \left(\frac{t_v}{100} \right)^6 + H \left(\frac{t_v}{100} \right)^7 \quad (25)$$

where for

32.000-164.270°F,	A = 1010.0;	B = 44.151;	C = -47.927;	D = 109.12;	E = -143.24;	F = 106.95;	G = -42.224;	H = 6.8214
164.270-260.115°F,	+ 926.04	+ 278.15	+ -259.11	+ 103.45	+ 12.916	+ -25.264	+ 7.9770	+ -.84472
260.115-304.355°F,	+ 1152.4	+ -58.085	+ -15.088	+ 10.994	+ 4.9441	+ -2.1177	+ -.098319	+ .066821
304.355-333.080°F,	+ 1062.5	+ 39.694	+ -26.716	+ 2.5549	+ 2.8504	+ -.35699	+ -.14970	+ .024932
333.080-354.340°F,	+ 715.17	+ 312.82	+ -87.151	+ 8.5512	+ -0-	+ -0-	+ -0-	+ -0-
354.940-390.825°F,	+ 878.56	+ 90.499	+ -10.290	+ 17.958	+ -11.035	+ 2.3748	+ -17491	+ -0-
390.825-469.040°F,	+ 645.25	+ 165.77	+ 24.555	+ -8.9322	+ -8.2059	+ 2.2157	+ -17004	+ -0-
469.040-609.025°F,	+ 571.64	+ 288.28	+ -27.377	+ -10.211	+ 2.5829	+ -.17955	+ -0-	+ -0-
609.025-705.400°F,	+ -108660.	+ 35268.	+ 714.75	+ -378.59	+ -288.21	+ 63.134	+ -3.4981	+ -0-

c. Internal Energy of Saturated Water (U_w) versus Temperature (t_w)

$$U_w(t_w) = A + B \left(\frac{t_w}{100} \right) + C \left(\frac{t_w}{100} \right)^2 + D \left(\frac{t_w}{100} \right)^3 + E \left(\frac{t_w}{100} \right)^4 \\ + F \left(\frac{t_w}{100} \right)^5 + G \left(\frac{t_w}{100} \right)^6 + H \left(\frac{t_w}{100} \right)^7 \quad (26)$$

where for

32.000-164.270°F,	A = -32.157;	B = 98.451;	C = 16.313;	D = -48.063;	E = 67.937;	F = -51.343;	G = 19.966;	H = -3.1374
164.270-260.115°F,	+ -35.709	+ 97.067	+ 15.190	+ -12.445	+ 2.2342	+ 1.4200	+ -.68265	+ .084643
260.115-304.355°F,	+ -32.870	+ 104.08	+ -3.8179	+ 1.2177	+ -10515	+ -0-	+ -0-	+ -0-
304.355-333.080°F,	+ -17.807	+ 99.656	+ -1.9722	+ -1.3908	+ .43729	+ .14011	+ -.035575	+ -0-
333.080-354.940°F,	+ -14.907	+ 87.377	+ 2.4714	+ -0-	+ -0-	+ -0-	+ -0-	+ -0-
354.940-390.825°F,	+ 217.45	+ 84.494	+ 28.695	+ 7.2721	+ -2.3629	+ .27406	+ -.050955	+ .0062920
390.825-469.040°F,	+ 166.42	+ -14.849	+ 9.4172	+ 3.4742	+ -.048579	+ -.070066	+ -.019760	+ .0036124
469.040-609.025°F,	+ 75.459	+ 31.096	+ 12.607	+ -.00067624	+ 1.4633	+ .021474	+ -.0051103	+ .00055580
609.025-705.400°F,	+ 88067.	+ -28142.	+ -579.17	+ 299.96	+ 231.71	+ -50.595	+ 2.7985	+ -0-

d. Saturated Water Temperature (t_w) versus Internal Energy (U_w)

$$t_w(U_w) = A + B \left(\frac{U_w}{100} \right) + C \left(\frac{U_w}{100} \right)^2 + D \left(\frac{U_w}{100} \right)^3 + E \left(\frac{U_w}{100} \right)^4 \\ + F \left(\frac{U_w}{100} \right)^5 + G \left(\frac{U_w}{100} \right)^6 + H \left(\frac{U_w}{100} \right)^7 \quad (27)$$

where for

000.000-132.145 Btu/lb,	A = 31.998;	B = 99.194;	C = 3.0336;	D = -2.9755;	E = -2.5922;	F = 8.2592;	G = -6.5430;	H = 1.7377
132.145-228.645 Btu/lb,	+ 45.621	+ 62.547	+ 40.878	+ -21.853	+ 5.7295	+ -.60158	+ -0-	+ -0-
228.645-273.855 Btu/lb,	+ 66.256	+ 64.148	+ 2.0729	+ 10.171	+ -4.3221	+ .52644	+ -0-	+ -0-
273.855-303.545 Btu/lb,	+ -38.823	+ 170.81	+ -28.318	+ 10.639	+ -4.7144	+ 1.1555	+ -.10322	+ -0-
303.545-326.365 Btu/lb,	+ -181.01	+ 171.79	+ 53.145	+ -14.441	+ -5.0171	+ -.010540	+ .80270	+ -.12315
326.365-364.295 Btu/lb,	+ 20.09	+ 109.78	+ -2.1994	+ -0-	+ -0-	+ -0-	+ -0-	+ -0-
364.295-449.900 Btu/lb,	+ 22.516	+ 74.262	+ 18.837	+ -1.8194	+ -.52120	+ -17979	+ .094611	+ -.0091883
449.900-622.850 Btu/lb,	+ -139.26	+ 164.33	+ 25.885	+ -17.219	+ 2.7626	+ -.0079634	+ -.035055	+ .0023235
622.850-872.900 Btu/lb,	+ -1863.3	+ 557.53	+ 179.13	+ -76.038	+ 7.8720	+ .20590	+ -.079408	+ .0035265

2. Specific Heat: Dry Air

The specific heat of dry air at constant volume is a function of its temperature (Assumption (17)). This functional relationship is a composite of the standard air constituent specific heats as functions of temperature, and the resulting equation is:⁷

$$c_{v,a}(T_a) = 0.243 - \frac{0.889}{(T_a + 459.69)^{1/2}} - \frac{58.964}{(T_a + 459.69)} + \frac{22348.050}{(T_a + 459.69)^2} \quad (28)$$

3. Specific Internal Energy Difference

The specific heat may be used in the following manner to determine the specific internal energy difference for subsystems other than the water subsystems and the water vapor in the air/water vapor subsystem:

$$U^1 - U^3 = c_v(T^1 - T^3) \quad (29)$$

Specific internal energies for the water subsystems and the water vapor are determined directly by the formulations discussed previously.

4. Partial Pressures: Air and Water Vapor

Partial pressures of the air and water vapor are given, respectively, by:

$$P_a = \frac{53.30 a_{13}^1 (T_{13} + 459.69)}{144V} \quad (30)$$

$$P_v = \frac{85.81 W_{v13}^1 (T_{13} + 459.69)}{144V} \quad (31)$$

The evaporation rate for water is empirically described by:⁸

$$w_e = 0.156 A_e (P_{sv}^2 - P_v^2)^{1.2} \quad (32)$$

Water vapor in the contained air/water vapor volume cannot exceed the saturated amount as determined from a variation of Eq. (31). Should it tend to exceed this amount, sufficient condensation must be allowed to maintain the saturated level.

5. Heat Generation

During the time interval, the primary source of heat is the reactor core or its constituents. This heat is generated in two ways. One is the residual reactor fission power after shutdown, which is given by:

$$R_{rf} = (948)(R_0)(\beta/\beta - \rho)[\exp(\rho\lambda t_s/\beta - \rho)] \quad (33)$$

The other arises from the fission product decay energy which, for a U^{235} -fueled reactor, is given by:⁹

$$\begin{aligned} R_{fp} &= (4.74)(R_0) \{ [A(t_s)](t_s) \exp[-a(t_s)] \\ &\quad - [A(t_0 + t_s)](t_0 + t_s) \exp[-a(t_0 + t_s)] \} \end{aligned} \quad (34)$$

where the constants

$$\begin{aligned} A &= 12.05; \quad a = 0.0639; \quad \text{for } 0.1 \leq \text{time} < 10 \text{ sec} \\ &= 15.31; \quad = 0.1807; \quad 10 \leq \text{time} \leq 150 \text{ sec} \\ &= 26.02; \quad = 0.2834; \quad 150 < \text{time} < 4 \times 10^6 \text{ sec (46.3 days)} \\ &= 53.18; \quad = 0.3350; \quad 4 \times 10^6 < \text{time} < 2 \times 10^8 \text{ sec (6.34 yr)} \end{aligned}$$

6. Containment Leakage

The fractional leakage rate from the containment building is given by:

$$\mu = R + S(P_+)^q + T(P_+)^r \quad (35)$$

where q, r, R, S, and T are specific constants supplied by the analyst.

IV. METHOD OF SOLUTION

A. Order of Calculations

The preceding equations are solved for each time interval, using a numerical iterative procedure together with an implicit method to solve the heat conduction equations. All initial values for each time interval are known, being inputs at the start of calculations or outputs computed for the preceding interval. For each time interval, system and subsystem characteristics are computed in the following order:

(1) Total amount of residual fission heat and decay heat emitted, by integrating Eqs. (33) and (34) over the time interval.

(2) Total amount of heat removed by refrigeration system, using a constant refrigeration rate supplied as problem input.

The following values are estimated:

- (3) Amount of water evaporated from the pool and spilled water subsystems, using initial vapor and saturated vapor pressures in Eq. (32).
- (4) Amounts of convective heat transferred, using initial temperatures in Eqs. (6)-(19).
- (5) Final gaseous and liquid subsystem temperatures, using in Eqs. (2)-(5), values computed in Steps (1)-(4).
- (6) Amount of water vapor condensed, using, in a variation of Eq. (31), final temperatures obtained in Step (5). Thus a false state of supersaturation is avoided. The final temperatures are revised in this calculation to account for the warming effect of condensation, since the heat of condensation is assumed to go into the contained air/water vapor subsystem.

The following revised, more accurately estimated values are determined:

- (7) Amount of water evaporated from pool and spilled water subsystems, using, in Eq. (32), interval-averaged values of the vapor and saturated vapor pressures. (NOTE: An interval-averaged value is the simple average of the initial and final value for the time interval.)
- (8) Amounts of convective heat transferred, using, in Eqs. (6)-(19), interval-averaged temperatures.
- (9) Final gaseous and liquid subsystem temperatures, using, in Eqs. (2)-(5), revised values computed in Steps (7)-(8).
- (10) Amount of water vapor condensed, using, in a variation of Eq. (31), revised final temperatures obtained in Step (9). These temperatures are again revised to account for the warming effect of condensation.

Steps (7) through (10) are repeated until there is an acceptably small change in the end-of-interval gaseous and liquid subsystem temperatures. Convergence is reached when the respective temperatures satisfy the equation:

$$(T_i - T_{i-1})/T_i \leq \epsilon \quad (36)$$

- (11) Node temperatures in the solid subsystems, using, in the family of Eqs. (20)-(21), interval-averaged temperatures of the bounding subsystems computed in Step (10).

- (12) Amount of air/water vapor which escapes to the surroundings, using the overpressure in Eq. (35).

At this point, acceptable final values for the time interval are recorded and become the inputs for calculations of the next time interval.

B. Computer Input

The symbols used in the following explanation of the input deck structure are for orderly cataloging only; they do not intentionally correspond to nomenclature used elsewhere in this report. Where appearing, I denotes a fixed point (integer) input, and X a floating point input.

Card No.: 1 Variables: I1, I2, I3 Format: 3I12

- I1 = 0 New problem.
- = 1 Continue old problem which was terminated because allowed computer time was exceeded.
- = 2 Continue previously completed problem.
- I2 = 0 Initial nodal temperatures for each solid subsystem are a specified constant value.
- = 1 Point-by-point initial nodal temperatures are to be read in for each solid subsystem.
- I3 = 0 Complete variable dump punched on cards is to be provided so that problem may be continued at a later time, if desired. When a previously completed problem is continued, an additional card with a new maximum computation time (Format: 1E12.5) must be inserted after the variable dump. No additional card is needed in the case of prematurely terminated problem, since the variable dump is complete.
- = 1 No variable dump is to be provided on punched cards. (Problem cannot be continued.)

Card No.: 2-5 Format: 1X, A5, 11A6

Any title desired, using columns 2-72 on each card.
Four cards must be used, even if some are left blank.

Card No.: 6 Variables: X1, X2, X3, X4, X5, X6 Format: 6E12.5

- X1 Maximum time (in seconds) in which computations are to be completed.
- X2 Computation time (in seconds) whereupon time increment for printing is to be changed.
- X3 Succeeding computation time (in seconds) whereupon time increment for printing is to be changed again.

Card No.: 6 (Contd.)

- X4 Printing increment (in seconds) up to X2 (must be an integer multiple of each of X7, X8, X9 on Card No. 7).
- X5 Printing increment (in seconds) from X2 to X3 (must be an integer multiple of X10 on Card No. 7).
- X6 Printing increment (in seconds) beyond X3 (must be an integer multiple of X11 on Card No. 7).

Card No.: 7 Variables: X7, X8, X9, X10, X11, X12 Format: 6E12.5

- X7 Computation time increment (in seconds) up to 10 seconds (must divide into 10 with an integer quotient; for example, X7 = 0.1, 1.0, 2.0, 5.0, 10.0).
- X8 Computation time increment (in seconds) from 10 to 150 seconds (must divide into 10 in the same manner as X7).
- X9 Computation time increment (in seconds) from 150 seconds to X2 (must divide into X2-150 with an integer quotient).
- X10 Computation time increment (in seconds) from X2 to X3 (must divide into X3-X2 with an integer quotient).
- X11 Computation time increment (in seconds) beyond X3 (must divide into X6 with an integer quotient).
- X12 = 1 Standard output format displaying temperatures, pressures, material inventories, and surface temperatures of all solid subsystems.
- = 2 Special (optional) output format displaying contained air/water vapor temperature, overpressure, and all nodal temperatures of certain solid subsystems.
- = 3 Combination of options 1 and 2.

Card No.: 8 Variables: X13, X14, X15, X16, X17, X18 Format: 6E12.5

- X13 Normal reactor operating power (in MW).
- X14 Time (in seconds) that reactor has been at normal power prior to accident and shutdown.
- X15 Fraction of total nuclear afterheat transferred directly to contained air/water vapor subsystem.
- X16 Fraction of total nuclear afterheat transferred directly to water subsystem on the lower floor.

Card No.: 8 (Contd.)

X17 Fraction of total nuclear afterheat transferred directly to water subsystem on the upper floor.

X18 Fraction of total nuclear afterheat transferred directly to pool water subsystem.

Card No.: 9 Variables: X19, X20, X21, X22, X23, X24 Format: 6E12.5

X19 Computation time after accident when refrigeration begins.

X20 Constant refrigeration (cooling) rate (in Btu/sec).

X21 Fraction of refrigeration (cooling) applied directly to air/water vapor subsystem.

X22 Fraction of refrigeration (cooling) applied directly to water on lower floor.

X23 Fraction of refrigeration (cooling) applied directly to water on upper floor.

X24 Fraction of refrigeration (cooling) applied directly to pool water.

Card No.: 10 Variables: X25, X26, X27, X28, X29, X30 Format: 6E12.5

X25 Computation time (in seconds) after accident when outside water brought in as a spray (injected spray) is turned off.

X26 Constant injected spray rate (in gal/sec).

X27 Constant temperature (in °F) at which injected spray is introduced.

X28 Time (in seconds) after accident when recirculating spray (taken from water on lower floor and cooled before spraying) is turned off.

X29 Constant recirculating spray rate (in gal/sec).

X30 Constant temperature (in °F) at which recirculating spray is introduced.

Card No.: 11 Variables: X31, X32, X33, X34

Format: 4E12.5

X31 Computation tolerance used in Eq. (36); 0.005 is suggested.

X32 Fraction of spray water that mixes with water on lower floor.

Card No.: 11 (Contd.)

- X33 Fraction of spray water that mixes with water on upper floor.
 X34 Fraction of spray water that mixes with pool water.

Card No.: 12 Variables: X35, X36, X37, X38, X39, X40 Format: 6E12.5

- X35 Constant surrounding atmospheric pressure (in psia).
 X36-X40 Constants R, S, q, T, r, respectively, in Eq. (35).

Card No.: 13 Variables: X41, X42, X43, X44, X45, X46 Format: 6E12.5

- X41 Volume (in ft^3) of contained air/water vapor subsystem.
 X42 Contact area (in ft^2) between pool water and contained air/water vapor subsystems.
 X43 Contact area (in ft^2) between water on lower floor and contained air/water vapor subsystem.
 X44 Contact area (in ft^2) between water on upper floor and contained air/water vapor subsystem.
 X45 Constant heat transfer coefficient (in $\text{Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$) between contained air/water vapor subsystem and any of the three water subsystems when heat flow is into the water.
 X46 Constant heat transfer coefficient (in $\text{Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$) between contained air/water vapor subsystem and any of the three water subsystems when heat flow is from the water.

Card No.: 14 Variables: X47, X48, X49, X50, X51 Format: 5E12.5

- X47-X51 Initial inventory (in lb) of contained dry air, contained water vapor, water on lower floor, water on upper floor, and pool water, respectively.

Card No.: 15 Variables: X52, X53, X54, X55, X56, X57 Format: 6E12.5

- X52-X55 Initial temperature (in $^\circ\text{F}$) of contained air/water vapor, water on lower floor, water on upper floor, and pool water, respectively.

Card No.: 15 (Contd.)

- X56 Constant surrounding atmospheric temperature (in °F).
 X57 Constant temperature (in °F) of surrounding soil and rock.

Card No.: 16 Variables: X58, X59, X60, X61, X62, X63 Format: 6E12.5

X58-X63 Constant inner-surface heat transfer coefficient (in $\text{Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$) for the dome, wall above grade, wall below grade, metal internal structures, concrete internal structures, and the lower floor not covered by water, respectively.

Card No.: 17 Variables: X64, X65, X66 Format: 3E12.5

X64-X66 Constant inner-surface heat transfer coefficient (in $\text{Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$) for lower floor covered by water, upper floor covered by water, and pool container, respectively.

Card No.: 18 Variables: X67, X68, X69, X70, X71, X72 Format: 6E12.5

X67-X72 Constant outer-surface heat transfer coefficient (in $\text{Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$) for the dome, wall above grade, wall below grade, metal internal structures, concrete internal structures, and the lower floor not covered by water, respectively.

Card No.: 19 Variables: X73, X74, X75 Format: 3E12.5

X73-X75 Constant outer-surface heat transfer coefficient (in $\text{Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$) for the lower floor covered by water, upper floor covered by water, and the pool container, respectively.

Card No.: 20 Variables: X76, X77, X78, X79, X80, X81 Format: 6E12.5

X76-X81 Surface area (in ft^2) of the dome, wall above grade, wall below grade, metal internal structures (total of both exposed sides), concrete internal structures (total of both exposed sides), and lower floor not covered by water, respectively.

The following cards are to be provided only if I2 = 1. In all cases, the Format is 6E12.5.

- Card No.: 105a ... Nodal temperatures (in °F) read in point-by-point from inner to outer surface for the dome. (Use as many cards as necessary.)
- Card No.: 106a ... Repeat Cards No. 105a ... for wall above grade.
- Card No.: 107a ... Repeat Cards No. 105a ... for wall below grade.
- Card No.: 108a ... Repeat Cards No. 105a ... for metal internal structures.
- Card No.: 109a ... Repeat Cards No. 105a ... for concrete internal structures.
- Card No.: 110a ... Repeat Cards No. 105a ... for lower floor not covered by water.
- Card No.: 111a ... Repeat Cards No. 105a ... for lower floor covered by water.
- Card No.: 112a ... Repeat Cards No. 105a ... for upper floor covered by water.
- Card No.: 113a ... Repeat Cards No. 105a ... for pool container.

C. Computer Output

The standard output for a problem (see Appendix A) consists of a printed listing of: (1) the input data, in order of appearance on the input cards; and (2) various computed values as functions of time after the accident. More specifically:

- (1) Time after accident (in days/hours-minutes-seconds).
- (2) Temperature of contained air/water vapor (in °F).
- (3) Temperature of water on lower floor (in °F).
- (4) Temperature of water on upper floor (in °F).
- (5) Temperature of pool water (in °F).
- (6) Containment overpressure (in psi).
- (7) Partial pressure of contained dry air (in psia).
- (8) Partial pressure of contained water vapor (in psia).
- (9) Inventory of contained dry air (in lb).

- (10) Inventory of contained water vapor (in lb).
- (11) Inventory of water on lower floor (in lb).
- (12) Inventory of water on upper floor (in lb).
- (13) Inventory of pool water (in lb).
- (14) Total amount of nuclear afterheat emitted (in Btu).
- (15) Condensation rate of contained vapor (in lb/sec).
- (16) Leakage rate of contained air/water vapor (in %/day).
- (17) Surface temperatures of all conducting subsystems (in °F).

The optional computed output consists of:

- (1) Time after the accident (in days/hours-minutes-seconds).
- (2) Temperature of contained air/water vapor (in °F).
- (3) Containment overpressure (in psi).
- (4) A complete set of nodal temperatures for all exterior, conducting subsystems except the lower floor not covered by water.

V. GENERAL APPLICABILITY

Although designed primarily for analysis of the AARR secondary containment system, the PTHISTRY Code was written so that it could be used for water-cooled reactor systems in general. To this end, most of the subsystems can be effectively isolated (deleted) from the total system by assigning zero values for their surface heat transfer coefficients. However, other parameters of the isolated subsystems (e.g., weight, conductivity, temperature, etc.) should be assigned nonzero "filler" values to avoid computer division by zero.

Although not specifically covered in the analytical development, time-dependent energy additions, other than that from nuclear afterheat (e.g., metal-water reactions or combustion of evolved hydrogen), can be included as a constant, negative, refrigeration rate in any system analysis. As noted in Section IIIA(3) and (5), such additions also can be considered on a time-independent basis ("one-shot" type) by altering the input values before code analysis begins. For example, such an energy addition to the containment atmosphere will cause the initial input values of pressure and temperature to be higher than the normal, preaccident values of these parameters.

The code also may be used in the analysis of a system accident wherein superheated water is expelled and flashes to water vapor. (This is not the case in the sample problem.) This is done by assuming that flashing has already occurred (under adiabatic conditions) and that the temperature of the remaining spilled water is at the reduced pressure boiling point for the secondary containment. Appropriate initial equilibrium conditions can be easily determined by hand calculation.

The code also may be employed to extend detailed blowdown calculations which normally are only of a short duration. In this event, the final system values determined by short-term blowdown analysis would be used as the input.

The computer running time for any problem is a function of the:

- (1) total number of solid subsystem nodes;
- (2) time length of the various computation intervals;
- (3) frequency of printed output;
- (4) value of the convergence criterion; and
- (5) time following the accident to which computations are to be carried.

For example, the running time for the sample problem described in Appendix A is 53 seconds on the CDC-3600 computer. No unusual library functions are needed for use by PTHISTORY. Also, all code instructions, including those of the subroutines, are written in the FORTRAN language; no machine language coding is employed. This code requires a computer with 32k of memory and should be easily adaptable for use on any computer which can process coding written in the FORTRAN language.

APPENDIX A

Sample Problem

The computer input and output displayed in this Appendix are illustrative of a hypothetical containment system problem which is amenable to solution by the PTHISTORY Code whose analytical and logical description is given in the text.

Consistent with the format statements of the FORTRAN program, the input information is placed on a form similar to the input data sheets reproduced on pages 39-44. The information on each line is then punched into a card which is numerically indexed to that line in columns 72 through 80. The complete set of cards constitutes the input deck for one problem.

A complete listing of the FORTRAN source deck is given in Appendix B.

Problem Input

The following explanatory comments are made with reference to input data to be punched on specific cards (numerical listing in columns 72-80 of input data sheets), and the corresponding instructions given in Section IV B.

Card No. 1: This is a new problem starting at time zero ($I1 = 0$). Initial nodal temperatures for the solid subsystems are to be read in point-by-point ($I2 = 1$). A complete variable dump on punched cards is to be provided so that the problem can be continued at a later time, if desired ($I3 = 0$).

Card No. 6: The solution time is to extend to 6 hours (21,600 seconds), with a first computation time interval change at 10 minutes (600 seconds) and a second change at 1 hour (3600 seconds). Computed values of output are to be printed: (1) every 10 seconds up to 10 minutes (600 seconds), which is the first computation time interval change; (2) every 5 minutes (300 seconds) up to 1 hour (3600 seconds), which is the second computation time interval change; and (3) every 15 minutes (900 seconds) beyond 1 hour.

Card No. 7: Since conditions change more rapidly immediately after the accident, shorter computation time intervals are used at first:

1 sec	$0 \text{ sec} < \text{time} \leq 10 \text{ sec}$
2 sec	$10 \text{ sec} < \text{time} \leq 150 \text{ sec}$
5 sec	$150 \text{ sec} < \text{time} \leq 600 \text{ sec}$
20 sec	$600 \text{ sec} < \text{time} \leq 3600 \text{ sec}$
100 sec	$3600 \text{ sec} < \text{time}$

Standard output is called for ($X12 = 1$).

Card No. 8: The reactor has been operating at a steady, normal power of 100 MW for 22 days (1,900,800 seconds). All afterheat generated will be transferred directly and instantaneously by an unspecified mode to the contained air/water vapor subsystem ($X_{15} = 1$). (This could represent the case of a completely uncovered core exposed to the contained air/water vapor subsystem.)

Card No. 9: Artificial refrigeration (cooling) is started at the time of the accident and continues indefinitely. The cooling rate is a constant 100 Btu/sec, and applies only to the contained air/water vapor subsystem ($X_{21} = 1$).

Card No. 10: Outside spray water at 65°F is brought into the containment at the rate of 1 gal/sec until it is shut off at 30 minutes (1800 seconds). No recirculating spray (0 gal/sec at 110°F) is provided; this is accomplished by shutting it off at time zero ($X_{28} = 0$).

Card No. 11: The convergence criterion (computation tolerance) is 0.005. As some of the contained water vapor condenses (due to decrease in temperature of contained air), it returns to the water subsystems with the following fractional allocation: 0.4 to the water on the lower floor; 0.5 to the water on the upper floor; and 0.1 to the pool water.

Card No. 12: The outside atmospheric pressure is a constant 14.3 psia. It is desired to allow uncontrolled leakage proportional to the square root of the overpressure, with a leakage rate of 1% per day at an overpressure of 7.5 psi. The constants necessary to achieve this (according to Eq. (35)) are given in the input ($X_{37} = 0.36515$ and $X_{38} = 0.5$).

Card No. 13: Total volume of the contained air/water vapor subsystem is 1,000,000 ft³. Surface areas of the pool, "lower" water, and "upper" water, respectively, are 500, 10,000, and 2,000 ft². The coefficient of heat transfer between the air/water vapor subsystem and any water subsystem is 3 Btu/(hr)(ft²)(°F) regardless of the direction of heat flow.

Card No. 14: Initial inventories of dry air and water vapor are 70,349 and 769 lb, respectively. These amounts are present in the given total volume at a temperature of 80°F, a pressure of 14.3 psia, and a relative humidity of 50%. Initial inventories of water on the lower floor, upper floor, and in the pool are 100,000, 50,000, and 2,000,000 lb, respectively.

Card No. 15: Initial temperatures for the air/water vapor subsystem, "lower" water, "upper" water, pool water, outside atmosphere, and surrounding rock and soil are 80, 200, 200, 85, 65, and 55°F, respectively.

Cards No. 16-17: Inner surface heat transfer coefficients for solid subsystems No. 1-9 are: 1, 1, 1, 1, 1, 1, 2, 2, and $2 \text{ Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$, respectively.

Cards No. 18-19: The corresponding outer surface heat transfer coefficients for the solid subsystems are: 1.5, 1.5, 0, 1, 1, 0, 0, 1, and $1 \text{ Btu}/(\text{hr})(\text{ft}^2)(^\circ\text{F})$, respectively.

Cards No. 20-21: Corresponding surface areas of the solid subsystems are: 16,000, 22,000, 9,000, 25,000 (total of both sides), 50,000 (total of both sides), 2,000, 10,000 (same as surface area of "lower" water), 2,000 (same as surface area of "upper" water), and $4,000 \text{ ft}^2$, respectively.

Cards No. 22-23: The initial temperature of each solid subsystem is 80°F . However, this temperature will be overridden by separate node values which will be read in on Cards No. 105-113 ($I2 = 1$).

Card No. 28: The dome consists of an inner layer of steel $1/2$ in. thick, a middle layer of concrete 1 ft thick, and an outer layer of insulation 2 in. thick. The first layer (steel) is to have three equally-spaced nodes (one each on the free surface, on the interface with the second layer, and in the middle of the layer); the second layer (concrete) four equally-spaced nodes; and the outer layer (insulation) three nodes. Since interface nodes are duplicated from layer to layer, this dome subsystem will have a total of 8 nodes; therefore, eight nodal temperatures must be provided on Cards No. 105a-b.

Card No. 29: The thickness (in feet) of each layer is given in inner-to-outer order.

Card No. 30: The density (in lb/ft^3) is given for each layer.

Card No. 31: The specific heat (in $\text{Btu}/(\text{lb})(^\circ\text{F})$) is given for each layer.

Card No. 32: The conductivity (in $\text{Btu}/(\text{hr})(\text{ft})(^\circ\text{F})$) is given for each layer.

Cards No. 37-41: The wall above grade consists of an inner layer of steel $3/8$ in. thick, and an outer layer of concrete 2 ft thick. Three nodes are assigned to the inner layer and five to the outer (concrete) layer, or a total of 7 nodes. The material properties are listed.

Cards No. 46-50: The wall below grade consists of an inner layer of steel $3/8$ in. thick and an outer layer of concrete 2.25 ft thick.

Cards No. 55-59: The metal internal structures are represented by a slab of steel 0.5 ft thick. (A certain amount of judicious estimation must be exercised to establish a good representation of the particular system being analyzed.)

Cards No. 64-68: The concrete internal structures are represented by a slab of concrete 0.5 ft thick. (Again, judicious estimation must be used.)

Cards No. 73-77: That part of the lower floor not covered by water (including the foundation mat) has an inner steel liner 3/8 in. thick and an outer concrete layer 6.333 ft thick.

Cards No. 82-86: That part of the lower floor covered by water (including the foundation mat) also has an inner steel liner 3/8 in. thick and an outer concrete layer 6.333 ft thick.

Cards No. 91-95: That part of the upper floor covered by water is concrete, 1 ft thick. (That part of the upper floor not covered by water is included in the concrete internal structures subsystem.)

Cards No. 100-104: The walls of the pool container are concrete, 2 ft thick.

Cards No. 105a-b: The inner-to-outer nodal temperatures for the dome are 81.1, 81.2, 81.3, 81.4, 81.5, 81.6, 81.7, and 81.8°F, respectively. (These temperatures have no significance; they are used for illustration only.)

Cards No. 106a-b: Nodal temperatures are given for the wall above grade.

Cards No. 107a-b: Nodal temperatures are given for the wall below grade.

Card No. 108a: Nodal temperatures are given for the metal internal structures.

Card No. 109a: Nodal temperatures are given for the concrete internal structures.

Cards No. 110a-b: Nodal temperatures are given for the lower floor not covered by water.

Cards No. 111a-b: Nodal temperatures are given for the lower floor covered by water.

Card No. 112a: Nodal temperatures are given for the upper floor covered by water.

Card No. 113a: Nodal temperatures are given for the pool container.

A card listing of the foregoing input data is reproduced on pages 45 and 46.

Problem Output

As mentioned earlier, the problem output includes a print-out of the initial input data along with computed system and subsystem characteristics monitored at specific times.

Reproduced on pages 47-57 is the output for the sample problem.

INPUT DATA

PROGRAM	PTHISTORY	PROBLEM	Sample	ORIGINATOR	DATE	PAGE	1	OF	6	8
1	2	3	4	5	6	7				
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 , 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9 0
	10	11	10							11
M A I I N I	T I T L E	C A R D	C P N T I N U E D							2
M A I I N I	T I T L E	C A R D	C P N T I N U E D							3
M A I I N I	T I T L E	C A R D	C P N T I N U E D							4
M A I I N I	T I T L E	C A R D	C P N T I N U E D							5
	21160101.	161001.	13161001.	1101.	1310101.	191001.				6
	11.	21.	51.	2101.	110101.	111.				7
	1,0,01.	1,9,0,0,8,0,01.	111.	101.	101.	101.				8
	101.	1101.	111.	01.	01.	01.				9
	18,0101.	111.	16151.	101.	101.	11101.				10
	10,0,5	114.	115.	111.	111.	111.				11
	114,1,3	101.	131615115	115.	115.	101.				12
	1,0,0,0,0,0,1.	51001.	110,0,0,0,1.	12,0,0,0,1.	1131.	131.				13
	7,0,3,14,91.	716191.	110,0,0,0,0,1.	15,0,0,0,0,1.	12,0,0,0,0,1.	1111.				14
	18101.	21001.	121001.	11851.	11651.	15151.				15
	11.	11.	111.	111.	111.	111.				16
	121.	21.	21.	11.	11.	11.				17
	11,15	11,15	101.	111.	111.	101.				18
	101.	111.	111.	111.	111.	111.				19
	1,6,0,0,0,1.	22100101.	19101001.	12150101.	15100101.	1210101.				20
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9 0	
	1	2	3	4	5	6	7			8

INPUT DATA

PROGRAM		PROBLEM		ORIGINATOR		DATE		PAGE 2 OF 6	
1	2	3	4	5	6	7	8		
1	2	3	4	5	6	7	8		
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9		
1 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0				1 2 1		
	8 0 1 .	8 0 1 .	8 0 1 .	8 0 1 .	8 0 1 .	8 0 1 .	8 0 1 .		
	8 0 1 .	8 0 1 .	8 0 1 .	8 0 1 .			1 2 2		
	8 0 1 .	8 0 1 .	8 0 1 .	8 0 1 .			1 2 3		
DIAIME	TITL	CAR	D				1 2 4		
DIAIME	TITL	CAR	CØN	I, N, U, E			1 2 5		
DIAIME	TITL	CAR	CØN	I, N, U, E			1 2 6		
DIAIME	TITL	CAR	CØN	I, N, U, E			1 2 7		
	3	3	4		3		1 2 8		
	0 4 1 1 6 1 7		1 1 .	1 1 6 1 6 1 7			1 2 9		
	4 8 5 .	1 1 4 4 .		9 1 . 5			1 3 0		
	1 1 1	1 1 3	1 1 4				1 3 1		
	2 6 .	1 1 .	1 0 2 0 8 3				1 3 2		
WAALI	A B Ø V	G R A D	E	T I T L E	C A R D		1 3 3		
WAALI	A B Ø V	G R A D	E	T I T L E	C A R D	C Ø N T I N U E	1 3 4		
WAALI	A B Ø V	G R A D	E	T I T L E	C A R D	C Ø N T I N U E	1 3 5		
WAALI	A B Ø V	G R A D	E	T I T L E	C A R D	C Ø N T I N U E	1 3 6		
	2	3	5				1 3 7		
	0 3 1 1 2 5	2 1 .					1 3 8		
	4 8 5 .	1 1 4 4 .					1 3 9		
	1 1	1 3					1 4 0		
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9		
	1	2	3	4	5	6	8		

INPUT DATA

PROGRAM	PROBLEM			ORIGINATOR	DATE	PAGE 3 OF 6		
	1	2	3	4	5	6	7	8
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
1 1 1 1 1 1 1 1 1 1	1 2 6 1.	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1
1 W A I L L I	1 B I E L Ø W	1 G R I A I D E	1 T I I T	1 L E	1 C I A R I D I			1 4 1 1
1 W A I L L I	1 B I E L Ø W	1 G R I A I D E	1 T I I T	1 L E	1 C I A R I D I	1 C I Ø N I T I I N I U E D I		1 4 2 1
1 W A I L L I	1 B I E L Ø W	1 G R I A I D E	1 T I I T	1 L E	1 C I A R I D I	1 C I Ø N I T I I N I U E D I		1 4 3 1
1 W A I L L I	1 B I E L Ø W	1 G R I A I D E	1 T I I T	1 L E	1 C I A R I D I	1 C I Ø N I T I I N I U E D I		1 4 4 1
1 W A I L L I	1 B I E L Ø W	1 G R I A I D E	1 T I I T	1 L E	1 C I A R I D I	1 C I Ø N I T I I N I U E D I		1 4 5 1
1 1 1 1 1 1 1 1 1 1	2	1 1 1 1 1 1 1 1 1 1	1 3	1 1 1 1 1 1 1 1 1 1	1 5	1 1 1 1 1 1 1 1 1 1		1 4 6 1
1 0 1 3 1 1 2 5		1 2 1 . 1 2 5						1 4 7 1
1 4 8 5 1.		1 1 4 1 4 1.						1 4 8 1
1 1 1 1 1 1 1 1 1 1	1 1 1	1 1 1 1 1 1 1 1 1 1	1 3					1 4 9 1
1 1 1 1 1 1 1 1 1 1	1 2 6 1.	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1					1 5 0 1
M E T A A L	1 I N T I E R N A I L I	S I T R U C T U R E	C I T U R E S	1	T I I T I L E	1 C I A R I D I		1 5 1 1
M E T A A L	1 I N T E R N A I L I	S I T R U C T U R E	C I T U R E S	1	T I I T I L E	1 C I A R I D I	1 C I Ø N T I I N I U E D I	1 5 2 1
M E T A A L	1 I N T I E R N A I L I	S I T R U C T U R E	C I T U R E S	1	T I I T I L E	1 C I A R I D I	1 C I Ø N T I I N I U E D I	1 5 3 1
M E T A A L	1 I N T I E R N A I L I	S I T R U C T U R E	C I T U R E S	1	T I I T I L E	1 C I A R I D I	1 C I Ø N T I I N I U E D I	1 5 4 1
1 1 1 1 1 1 1 1 1 1	1	1 1 1 1 1 1 1 1 1 1	1 4	1 1 1 1 1 1 1 1 1 1				1 5 5 1
1 1 1 1 1 1 1 1 1 1	1 . 5	1 1 1 1 1 1 1 1 1 1						1 5 6 1
1 4 8 5 1.		1 1 1 1 1 1 1 1 1 1						1 5 7 1
1 1 1 1 1 1 1 1 1 1	1 1 1	1 1 1 1 1 1 1 1 1 1						1 5 8 1
1 1 1 1 1 1 1 1 1 1	1 2 6 1.	1 1 1 1 1 1 1 1 1 1						1 5 9 1
C I O N Q R E T I E	I N T E R N A I	S T R U C T U R E S	I T I I T I E	1 C A R D				1 6 0 1
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
1	2	3	4	5	6	7	8	

INPUT DATA

PROGRAM		PROBLEM		ORIGINATOR		DATE		PAGE 4 OF 6	
1	2	3	4	5	6	7	8		
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9		
1 C 0 N G R E T E	I I	N I T E R N A L	I S T R U C T U R E	S I T I T L E	C A R D	C 0 N T I N U E	D I	6,1	
1 C 0 N G R E T E	I I	N I T E R N A L	I S T R U C T U R E	S I T I T L E	C A R D	C 0 N T I N U E	D I	6,2	
C 0 N G R E T E	I I	N I T E R N A L	I S T R U C T U R E	S I T I T L E	C A R D	C 0 N T I N U E	D I	6,3	
1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	6,4	
1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	6,5	
1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	6,6	
1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	6,7	
1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	6,8	
L 0 W E R	I F L 0 P R I	I N Q T	C 0 V I E R E D	B Y I W A T E R I	T I T L E	C A R D	D I	6,9	
L 0 W E R	I F L 0 P R I	I N Q T	C 0 V I E R E D	B Y I W A T E R I	T I T L E	C A R D	C 0 N T I N U E D I	7,0	
L 0 W E R	I F L 0 P R I	I N Q T	C 0 V I E R E D	B Y I W A T E R I	T I T L E	C A R D	C 0 N T I N U E D I	7,1	
L 0 W E R	I F L 0 P R I	I N Q T	C 0 V I E R E D	B Y I W A T E R I	T I T L E	C A R D	C 0 N T I N U E D I	7,2	
1 1 1 1 1	2 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	7,3	
1 1 1 1 1	0 3 1 2 5	1 6 1 1 3 3 3	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	7,4	
1 1 1 1 1	4 8 5 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	7,5	
1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	7,6	
1 1 1 1 1	2 6 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	7,7	
L 0 W E R	I F L 0 P R I	C 0 V I E R E D	B Y I W A T E R I	T I T L E	C A R D	D I	D I	7,8	
L 0 W E R	I F L 0 P R I	C 0 V I E R E D	B Y I W A T E R I	T I T L E	C A R D	C 0 N T I N U E D I	D I	7,9	
L 0 W E R	I F L 0 P R I	C 0 V I E R E D	B Y I W A T E R I	T I T L E	C A R D	C 0 N T I N U E D I	D I	8,0	
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9		
1	2	3	4	5	6	7	8		

INPUT DATA

PROGRAM	PROBLEM	ORIGINATOR	DATE	PAGE 5 OF 6				
	1	2	3	4	5	6	7	8
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
,L,Ø,W,E,R	,F,L,Ø,Ø,R	,C,Ø,V,E,R,E,D	B,Y,W,A,T,E,R	T,I,T,L,E	C,A,R,D	C,Ø,N,T,I,N,U,E,D		
	2		3		5			
	.0,3,1,2,5		.6,1,3,3,3					
	1,4,8,5,		1,1,4,4,					
	1,1,1		1,1,3					
	1,2,6,		1,					
U,P,P,E,R	F,L,Ø,Ø,R	C,Ø,V,E,R,E,D	B,Y,W,A,T,E,R	T,I,T,L,E	C,A,R,D			
U,P,P,E,R	F,L,Ø,Ø,R	C,Ø,V,E,R,E,D	B,Y,W,A,T,E,R	T,I,T,L,E	C,A,R,D	C,Ø,N,T,I,N,U,E,D		
U,P,P,E,R	F,L,Ø,Ø,R	C,Ø,V,E,R,E,D	B,Y,W,A,T,E,R	T,I,T,L,E	C,A,R,D	C,Ø,N,T,I,N,U,E,D		
U,P,P,E,R	F,L,Ø,Ø,R	C,Ø,V,E,R,E,D	B,Y,W,A,T,E,R	T,I,T,L,E	C,A,R,D	C,Ø,N,T,I,N,U,E,D		
	1		1,4					
	1,							
	1,1,4,4,							
	1,1,3							
	1,							
I,P,Ø,Ø,L	C,Ø,N,T,I,N,E,R	T,I,T,L,E	C,A,R,D					
I,P,Ø,Ø,L	C,Ø,N,T,I,N,E,R	T,I,T,L,E	C,A,R,D	C,Ø,N,T,I,N,U,E,D				
I,P,Ø,Ø,L	C,Ø,N,T,I,N,E,R	T,I,T,L,E	C,A,R,D	C,Ø,N,T,I,N,U,E,D				
I,P,Ø,Ø,L	C,Ø,N,T,I,N,E,R	T,I,T,L,E	C,A,R,D	C,Ø,N,T,I,N,U,E,D				
	1		1,4					
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
	1	2	3	4	5	6	7	8

INPUT DATA

PROGRAM	PROBL EM	ORIGINATOR	DATE	PAGE 6 OF 6			
1	2	3	4	5	6	7	8
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
1 1 1 1 1	1 2 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 0 1 1
1 1 1 1 1	1 4 4 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 0 1 2
1 1 1 1 1	1 1 3	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 0 1 3
1 1 1 1 1	1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 0 1 4
1 1 1 1 1	8 1 1 . 1	1 8 1 1 . 2	1 8 1 1 . 3	1 8 1 1 . 4	1 8 1 1 . 5	1 8 1 1 . 6	1 1 0 5 A
1 1 1 1 1	1 8 1 1 . 7	1 8 1 1 . 8					1 1 0 5 B
1 1 1 1 1	1 8 2 1 . 1	1 8 2 1 . 2	1 8 2 1 . 3	1 8 2 1 . 4	1 8 2 1 . 5	1 8 2 1 . 6	1 1 0 6 A
1 1 1 1 1	1 8 2 1 . 7						1 1 0 6 B
1 1 1 1 1	1 8 3 1 . 1	1 8 3 1 . 2	1 8 3 1 . 3	1 8 3 1 . 4	1 8 3 1 . 5	1 8 3 1 . 6	1 1 0 7 A
1 1 1 1 1	1 8 3 1 . 7						1 1 0 7 B
1 1 1 1 1	1 8 4 1 . 1	1 8 4 1 . 2	1 8 4 1 . 3	1 8 4 1 . 4			1 1 0 8 A
1 1 1 1 1	1 8 5 1 . 1	1 8 5 1 . 2	1 8 5 1 . 3	1 8 5 1 . 4			1 1 0 9 A
1 1 1 1 1	1 8 6 1 . 1	1 8 6 1 . 2	1 8 6 1 . 3	1 8 6 1 . 4	1 8 6 1 . 5	1 8 6 1 . 6	1 1 1 1 0 A
1 1 1 1 1	1 8 6 1 . 7						1 1 1 1 0 B
1 1 1 1 1	1 8 7 1 . 1	1 8 7 1 . 2	1 8 7 1 . 3	1 8 7 1 . 4	1 8 7 1 . 5	1 8 7 1 . 6	1 1 1 1 1 A
1 1 1 1 1	1 8 7 1 . 7						1 1 1 1 1 B
1 1 1 1 1	1 8 8 1 . 1	1 8 8 1 . 2	1 8 8 1 . 3	1 8 8 1 . 4			1 1 1 1 2 A
1 1 1 1 1	1 8 9 1 . 1	1 8 9 1 . 2	1 8 9 1 . 3	1 8 9 1 . 4			1 1 1 1 3 A
1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
	1	2	3	4	5	6	7
							8

MAIN	TITLE	CARD	0	1	0	1
MAIN	TITLE	CARD	CONTINUED			2
MAIN	TITLE	CARD	CONTINUED			3
MAIN	TITLE	CARD	CONTINUED			4
21600.	600.	3600.	10.	300.	900.	5
1.	2.	5.	20.	100.	1.	6
100.	1900800.	1.	0.	0.	0.	7
0.	100.	1.	0.	0.	0.	8
1800.	1.	65.	0.	0.	0.	9
.005	.4	.5	.1			10
14.3	0.	.36515	.5	0.	0.	11
1000000.	500.	10000.	2000.	3.	3.	12
70349.	769.	100000.	50000.	2000000.		13
80.	200.	200.	95.	65.	55.	14
1.	1.	1.	1.	1.	1.	15
2.	2.	2.				16
1.5	1.5	0.	1.	1.	0.	17
0.	1.	1.				18
16000.	22000.	9000.	25000.	50000.	2000.	19
10000.	2000.	4000.				20
80.	80.	80.	80.	80.	80.	21
	80.	80.				22
DOME	TITLE	CARD				23
DOME	TITLE	CARD	CONTINUED			24
DOME	TITLE	CARD	CONTINUED			25
DOME	TITLE	CARD	CONTINUED			26
3	3	4	3			27
.04167	1.	.16667				28
485.	144.	9.5				29
.11	.13	.14				30
26.	1.	.02083				31
WALL	ABOVE	GRADE	TITLE	CARD		32
WALL	ABOVE	GRADE	TITLE	CARD	CONTINUED	33
WALL	ABOVE	GRADE	TITLE	CARD	CONTINUED	34
WALL	ABOVE	GRADE	TITLE	CARD	CONTINUED	35
2	3	5				36
.03125	2.					37
485.	144.					38
.11	.13					39
26.	1.					40
WALL	BELLOW	GRADE	TITLE	CARD		41
WALL	BELLOW	GRADE	TITLE	CARD	CONTINUED	42
WALL	BELLOW	GRADE	TITLE	CARD	CONTINUED	43
WALL	BELLOW	GRADE	TITLE	CARD	CONTINUED	44
2	3	5				45
.03125	2.25					46
485.	144.					47
.11	.13					48
26.	1.					49
METAL	INTERNAL	STRUCTURES	TITLE	CARD		50
METAL	INTERNAL	STRUCTURES	TITLE	CARD	CONTINUED	51
METAL	INTERNAL	STRUCTURES	TITLE	CARD	CONTINUED	52
METAL	INTERNAL	STRUCTURES	TITLE	CARD	CONTINUED	53
1	4					54
,5						55
485.						56
.11						57
26.						58
CONCRETE	INTERNAL	STRUCTURES	TITLE	CARD		59

CONCRETE	INTERNAL	STRUCTURES	TITLE	CARD	CONTINUED	61
CONCRETE	INTERNAL	STRUCTURES	TITLE	CARD	CONTINUED	62
CONCRETE	INTERNAL	STRUCTURES	TITLE	CARD	CONTINUED	63
	1	4				64
	.5					65
144.						66
.13						67
1.						68
LOWER	FLOOR	NOT COVERED BY WATER	TITLE	CARD		69
LOWER	FLOOR	NOT COVERED BY WATER	TITLE	CARD	CONTINUED	70
LOWER	FLOOR	NOT COVERED BY WATER	TITLE	CARD	CONTINUED	71
LOWER	FLOOR	NOT COVERED BY WATER	TITLE	CARD	CONTINUED	72
	2	3	5			73
.03125	6.333					74
485.	144.					75
.11	.13					76
26.	1.					77
LOWER	FLOOR	COVERED BY WATER	TITLE	CARD		78
LOWER	FLOOR	COVERED BY WATER	TITLE	CARD	CONTINUED	79
LOWER	FLOOR	COVERED BY WATER	TITLE	CARD	CONTINUED	80
LOWER	FLOOR	COVERED BY WATER	TITLE	CARD	CONTINUED	81
	2	3	5			82
.03125	6.333					83
485.	144.					84
.11	.13					85
26.	1.					86
UPPER	FLOOR	COVERED BY WATER	TITLE	CARD		87
UPPER	FLOOR	COVERED BY WATER	TITLE	CARD	CONTINUED	88
UPPER	FLOOR	COVERED BY WATER	TITLE	CARD	CONTINUED	89
UPPER	FLOOR	COVERED BY WATER	TITLE	CARD	CONTINUED	90
	1	4				91
	1.					92
144.						93
.13						94
1.						95
POOL	CONTAINER	TITLE	CARD			96
POOL	CONTAINER	TITLE	CARD	CONTINUED		97
POOL	CONTAINER	TITLE	CARD	CONTINUED		98
POOL	CONTAINER	TITLE	CARD	CONTINUED		99
	1	4				100
	2.					101
144.						102
.13						103
1.						104
81.1	81.2	81.3	81.4	81.5	81.6	105A
81.7	81.8					105B
82.1	82.2	82.3	82.4	82.5	82.6	106A
82.7						106B
83.1	83.2	83.3	83.4	83.5	83.6	107A
83.7						107B
84.1	84.2	84.3	84.4			108A
85.1	85.2	85.3	85.4			109A
86.1	86.2	86.3	86.4	86.5	86.6	110A
86.7						110B
87.1	87.2	87.3	87.4	87.5	87.6	111A
87.7						111B
88.1	88.2	88.3	88.4			112A
89.1	89.2	89.3	89.4			113A

.....CONTAINMENT OVERPRESSURE AND RELATED PARAMETERS AS FUNCTIONS OF TIME FOLLOWING A WATER-EXPULSION ACCIDENT.....

MAIN TITLE CARD
MAIN TITLE CARD CONTINUED
MAIN TITLE CARD CONTINUED
MAIN TITLE CARD CONTINUED

INITIAL INPUT INFORMATION

MAX. TIME	FIRST BREAK AT	SECOND BREAK AT	FIRST PRINT INCREMENT	SECOND PRINT INCREMENT	THIRD PRINT INCREMENT
21600	600	3600	10,000	300,000	900,000

TIME INCREMENTS FOR COMPUTATION PURPOSES					OUTPUT OPTION
FIRST	SECOND	THIRD	FOURTH	FIFTH	*****
1.000	2.000	5,000	20,000	100,000	1

POWER	TIME AT POWER	DECAY HEAT TO AIR	.....TO LOWER WATER	.....TO UPPER WATER	.....TO POOL WATER
100,000	1900800,000	1.000	0,000	0,000	0,000

START REFRIG. AT	REFRIG.	REFRIG. FROM AIR	.....FROM LOWER WATER	.....FROM UPPER WATER	.....FROM POOL WATER
0	100	1,000	0,000	0,000	0,000

END INJECT SPRAY AT	INJECT SPRAY RATE	INJECT SPRAY TEMP.	END RECIRC. SPRAY AT	RECIRC. SPRAY RATE RECIRC. SPRAY TEMP.	
1800	1,000	65,000	0	0,000	110,000

COMPUTATION TOLERANCE	CONDENSATE TO LOWER WATER	.....TO UPPER WATER	.....TO POOL WATER
0.0050000	0,400	0,500	0,100

ATMOSPHERIC PRESSURE	LEAK PARAMETER 1	...PARAMETER 2	...PARAMETER 3	...PARAMETER 4	...PARAMETER 5
14.3000	0,0000	0,3651	0,5000	0,0000	0,0000

CONTAINED VOLUME	AIR=POOL AREA	AIR=LOWER WATER AREA	AIR=UPPER WATER AREA	H.T.COEF. AIR-WATER	H.T.COEF. WATER-AIR
1000000	500	10000	2000	3,000	3,000

AIR	WATER VAPOR	INITIAL INVENTORIES		
70349,00	769,00	LOWER WATER	UPPER WATER	POOL WATER
		100000,00	50000,00	200000,00

CONTAINED AIR	LOWER WATER	INITIAL TEMPERATURES		
80,000	200,000	UPPER WATER	POOL WATER	OUTSIDE ATMOSPHERE
		200,000	85,000	65,000
				SURROUNDING EARTH
				55,000

FIRST	SECOND	THIRD	CONDUCTING SUBSYSTEM PARAMETERS					
			FOURTH	FIFTH	SIXTH	SEVENTH	EIGHTH	NINTH
1.000	1.000	1.000	INNER SURFACE HEAT TRANSFER COEFFICIENTS					
			1.000	1.000	1.000	2,000	2,000	2,000

1.500	1.500	0,000	OUTER SURFACE HEAT TRANSFER COEFFICIENTS					
			1.000	1.000	0,000	0,000	1,000	1,000

16000	22000	9000	HEAT CONDUCTION AREAS					
			25000	50000	2000	10000	2000	4000

80,000	80,000	80,000	INITIAL TEMPERATURES					
			80,000	80,000	80,000	80,000	80,000	80,000

DOME TITLE CARD
 DOME TITLE CARD CONTINUED
 DOME TITLE CARD CONTINUED
 DOME TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 1 WHICH CONTAINS 3 CONDUCTING LAYERS *****

LAYER NUMBER	1	2	3		
TOTAL NODES	3	4	3		
THICKNESS	0.0417	1.0000	0.1667		
DENSITY	485.0000	144.0000	9.5000		
HEAT CAPACITY	0.1100	0.1300	0.1400		
CONDUCTIVITY	26.0000	1.0000	0.0208		
NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATE WITH EACH NODE
1	0.0208	26.0000	0.0104	0.1100	485.0000
2	0.0208	26.0000	0.0208	0.1200	485.0000
3	0.3333	1.0000	0.1771	0.1288	164.0603
4	0.3333	1.0000	0.3333	0.1300	144.0000
5	0.3333	1.0000	0.3333	0.1300	144.0000
6	0.0833	0.0208	0.2083	0.1320	117.0996
7	0.0833	0.0208	0.0833	0.1400	9.5000
8			0.0417	0.1400	9.5000

WALL ABOVE GRADE TITLE CARD
 WALL ABOVE GRADE TITLE CARD CONTINUED
 WALL ABOVE GRADE TITLE CARD CONTINUED
 WALL ABOVE GRADE TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 2 WHICH CONTAINS 2 CONDUCTING LAYERS *****

LAYER NUMBER	1	2			
TOTAL NODES	3	5			
THICKNESS	0.0313	2.0000			
DENSITY	485.0000	144.0000			
HEAT CAPACITY	0.1100	0.1300			
CONDUCTIVITY	26.0000	1.0000			
NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATE WITH EACH NODE
1	0.0156	26.0000	0.0078	0.1100	485.0000
2	0.0156	26.0000	0.0156	0.1100	485.0000
3	0.5000	1.0000	0.2578	0.1294	154.3333
4	0.5000	1.0000	0.5000	0.1300	144.0000
5	0.5000	1.0000	0.5000	0.1300	144.0000
6	0.5000	1.0000	0.5000	0.1300	144.0000
7	0.5000	1.0000	0.2500	0.1300	144.0000

WALL BELOW GRADE TITLE CARD
 WALL BELOW GRADE TITLE CARD CONTINUED
 WALL BELOW GRADE TITLE CARD CONTINUED
 WALL BELOW GRADE TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 3 WHICH CONTAINS 2 CONDUCTING LAYERS *****

LAYER NUMBER	1	2			
TOTAL NODES	3	5			
THICKNESS	0.0313	2.2500			
DENSITY	485.0000	144.0000			
HEAT CAPACITY	0.1100	0.1300			
CONDUCTIVITY	26.0000	1.0000			
NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATED WITH EACH NODE
1	0.0156	26.0000	0.0078	0.1100	485.0000
2	0.0156	26.0000	0.0156	0.1100	485.0000
3	0.5625	1.0000	0.2891	0.1295	144.2162
4	0.5625	1.0000	0.5625	0.1300	144.0000
5	0.5625	1.0000	0.5625	0.1300	144.0000
6	0.5625	1.0000	0.5625	0.1300	144.0000
7	0.5625	1.0000	0.2813	0.1300	144.0000

METAL INTERNAL STRUCTURES TITLE CARD
 METAL INTERNAL STRUCTURES TITLE CARD CONTINUED
 METAL INTERNAL STRUCTURES TITLE CARD CONTINUED
 METAL INTERNAL STRUCTURES TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 4 WHICH CONTAINS 1 CONDUCTING LAYERS *****

LAYER NUMBER	1				
TOTAL NODES	4				
THICKNESS	0.5000				
DENSITY	485.0000				
HEAT CAPACITY	0.1100				
CONDUCTIVITY	26.0000				
NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATED WITH EACH NODE
1	0.1667	26.0000	0.0833	0.1100	485.0000
2	0.1667	26.0000	0.1667	0.1100	485.0000
3	0.1667	26.0000	0.1667	0.1100	485.0000
4	0.1667	26.0000	0.0833	0.1100	485.0000

CONCRETE INTERNAL STRUCTURES TITLE CARD
 CONCRETE INTERNAL STRUCTURES TITLE CARD CONTINUED
 CONCRETE INTERNAL STRUCTURES TITLE CARD CONTINUED
 CONCRETE INTERNAL STRUCTURES TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 5 WHICH CONTAINS 1 CONDUCTING LAYERS *****

LAYER NUMBER 1
 TOTAL NODES 4
 THICKNESS 0.5000
 DENSITY 144.0000
 HEAT CAPACITY 0.1300
 CONDUCTIVITY 1.0000

NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATED WITH EACH NODE
1	0.1667	1.0000	0.0833	0.1300	144.0000
2	0.1667	1.0000	0.1667	0.1300	144.0000
3	0.1667	1.0000	0.1667	0.1300	144.0000
4			0.0833	0.1300	144.0000

LOWER FLOOR NOT COVERED BY WATER TITLE CARD
 LOWER FLOOR NOT COVERED BY WATER TITLE CARD CONTINUED
 LOWER FLOOR NOT COVERED BY WATER TITLE CARD CONTINUED
 LOWER FLOOR NOT COVERED BY WATER TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 6 WHICH CONTAINS 2 CONDUCTING LAYERS *****

LAYER NUMBER 1 2
 TOTAL NODES 3 5
 THICKNESS 0.0313 6.3330
 DENSITY 485.0000 144.0000
 HEAT CAPACITY 0.1100 0.1300
 CONDUCTIVITY 26.0000 1.0000

NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATED WITH EACH NODE
1	0.0156	26.0000	0.0078	0.1100	485.0000
2	0.0156	26.0000	0.0156	0.1100	485.0000
3	1.5832	1.0000	0.7994	0.1298	147.3324
4	1.5832	1.0000	1.5832	0.1300	144.0000
5	1.5832	1.0000	1.5832	0.1300	144.0000
6	1.5832	1.0000	1.5832	0.1300	144.0000
7	1.5832	1.0000	0.7916	0.1300	144.0000

LOWER FLOOR COVERED BY WATER TITLE CARD
 LOWER FLOOR COVERED BY WATER TITLE CARD CONTINUED
 LOWER FLOOR COVERED BY WATER TITLE CARD CONTINUED
 LOWER FLOOR COVERED BY WATER TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 7 WHICH CONTAINS 2 CONDUCTING LAYERS *****

LAYER NUMBER	1	2			
TOTAL NODES	3	5			
THICKNESS	0.0313	6.3330			
DENSITY	485.0000	144.0000			
HEAT CAPACITY	0.1100	0.1300			
CONDUCTIVITY	26.0000	1.0000			
NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATED WITH EACH NODE
1	0.0156	26.0000	0.0078	0.1100	485.0000
2	0.0156	26.0000	0.0156	0.1100	485.0000
3	1.5832	1.0000	0.7994	0.1298	144.3324
4	1.5832	1.0000	1.5832	0.1300	144.0000
5	1.5832	1.0000	1.5832	0.1300	144.0000
6	1.5832	1.0000	1.5832	0.1300	144.0000
7			0.7916	0.1300	144.0000

UPPER FLOOR COVERED BY WATER TITLE CARD
 UPPER FLOOR COVERED BY WATER TITLE CARD CONTINUED
 UPPER FLOOR COVERED BY WATER TITLE CARD CONTINUED
 UPPER FLOOR COVERED BY WATER TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 8 WHICH CONTAINS 1 CONDUCTING LAYERS *****

LAYER NUMBER	1				
TOTAL NODES	4				
THICKNESS	1.0000				
DENSITY	144.0000				
HEAT CAPACITY	0.1300				
CONDUCTIVITY	1.0000				
NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATED WITH EACH NODE
1	0.3333	1.0000	0.1667	0.1300	144.0000
2	0.3333	1.0000	0.3333	0.1300	144.0000
3	0.3333	1.0000	0.3333	0.1300	144.0000
4			0.1667	0.1300	144.0000

POOL CONTAINER TITLE CARD
 POOL CONTAINER TITLE CARD CONTINUED
 POOL CONTAINER TITLE CARD CONTINUED
 POOL CONTAINER TITLE CARD CONTINUED

ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSTEM NUMBER 9 WHICH CONTAINS 1 CONDUCTING LAYERS *****

LAYER NUMBER 1
 TOTAL NODES 4
 THICKNESS 2.0000
 DENSITY 144.0000
 HEAT CAPACITY 0.1300
 CONDUCTIVITY 1.0000

NODE NUMBER	DISTANCE BETWEEN NODES	CONDUCTIVITY BETWEEN NODES	THICKNESS ASSOCIATED WITH EACH NODE	HEAT CAPACITY ASSOCIATED WITH EACH NODE	DENSITY ASSOCIATED WITH EACH NODE
1	0.6667	1.0000	0.3333	0.1300	144.0000
2	0.6667	1.0000	0.6667	0.1300	144.0000
3	0.6667	1.0000	0.6667	0.1300	144.0000
4	0.6667	1.0000	0.3333	0.1300	144.0000

ALL SUBSYSTEM NODAL TEMPERATURES HAVE BEEN READ IN POINT-BY-POINT AS FOLLOWS-

SECTION

1	81.10	81.20	81.30	81.40	81.50	81.60	81.70	81.80
2	82.10	82.20	82.30	82.40	82.50	82.60	82.70	
3	83.10	83.20	83.30	83.40	83.50	83.60	83.70	
4	84.10	84.20	84.30	84.40				
5	85.10	85.20	85.30	85.40				
6	86.10	86.20	86.30	86.40	86.50	86.60	86.70	
7	87.10	87.20	87.30	87.40	87.50	87.60	87.70	
8	88.10	88.20	88.30	88.40				
9	89.10	89.20	89.30	89.40				

COMPUTED OUTPUT

*****TEMPERATURES***** *****PRESSURES***** *****INVENTORIES***** *****RAIES*****

TIME	AIR	WATER	POOL	OVER	AIR VAPOR		AIR VAPOR	AIR VAPOR	WATER	WATER	POOL	DECAY	CONDEN-	HEAT	SATION	LEAKAGE
					FIRST	SECOND	THIRD	FOURTH	FIFTH	SIXTH	SEVENTH	EIGHTH	NINTH			
(CONDUCTING SUBSYSTEM SURFACE TEMPERATURES - INNER/OUTER)																
0/ 0= 0 80.0	200.0	200.0	85.0	0.000	14.053	0.247	70349	769	100000	50000	2000000	0	0.0000	0.00073/		
(			81.10	82.10	83.10	84.10	85.10	86.10	87.10	88.10	89.10					
			81.80	82.70	83.70	84.40	85.40	86.70	87.70	88.40	89.40					
0/ 0= 10 90.6	199.1	199.7	85.0	0.311	14.328	0.283	70349	863	100005	49984	2000000	111856	0.0000	0.20359/		
(			81.26	82.28	83.28	84.11	85.10	86.29	87.56	88.30	89.10					
			80.59	82.68	83.70	84.39	85.40	86.70	87.70	88.40	89.40					
0/ 0= 20 97.4	198.3	199.5	85.0	0.522	14.505	0.317	70349	955	100011	49969	2000000	184006	0.0000	0.26392/		
(			81.28	82.29	83.29	84.12	85.12	86.30	87.61	88.50	89.09					
			79.48	82.67	83.70	84.39	85.41	86.70	87.70	88.40	89.40					
0/ 0= 30 102.3	197.5	199.2	85.0	0.683	14.633	0.350	70349	1045	100020	49953	2000000	236941	0.0000	0.301764		
(			81.30	82.31	83.31	84.14	85.15	86.31	87.64	88.69	89.09					
			78.46	82.65	83.70	84.39	85.44	86.70	87.70	88.41	89.40					
0/ 0= 40 106.1	196.7	198.9	85.0	0.815	14.733	0.382	70349	1133	100030	49938	2000000	280001	0.0000	0.329724		
(			81.31	82.32	83.32	84.16	85.18	86.32	87.68	88.89	89.09					
			77.53	82.64	83.70	84.39	85.47	86.70	87.70	88.43	89.41					
0/ 0= 50 109.4	195.9	198.6	85.0	0.931	14.817	0.413	70349	1219	100042	49923	2000000	317784	0.0000	0.352296		
(			81.33	82.33	83.33	84.18	85.22	86.32	87.71	89.08	89.08					
			76.68	82.62	83.70	84.40	85.51	86.70	87.70	88.44	89.42					
0/ 0= 1= 0 112.2	195.1	198.4	85.0	1.035	14.891	0.444	70349	1303	100056	49908	2000000	352536	0.0000	0.371479		
(			81.35	82.35	83.34	84.20	85.27	86.33	87.74	89.27	89.08					
			75.90	82.61	83.70	84.40	85.55	86.70	87.70	88.46	89.43					

0/ 0- 9- 0 137.5 171.6 187.8	85.0 2.673 15.552 1.421 70347	3994 101925 49333 2000000 1477896 0.0000 0.597044
(82.53 83.43 84.32 84.91 88.52 88.74 89.19 97.11 88.91	67.18 81.89 83.70 84.93 88.71 86.70 87.70 90.26 90.38	
0/ 0- 9-10 137.4 171.2 187.6	85.0 2.682 15.547 1.434 70347	4032 101980 49323 2000000 1496529 0.0000 0.597945
(82.66 83.45 84.34 84.92 88.57 86.75 89.22 97.25 88.91	67.16 81.87 83.69 84.94 88.77 86.70 87.70 90.29 90.38	
0/ 0- 9-20 137.2 170.9 187.4	85.0 2.689 15.542 1.447 70347	4069 102035 49313 2000000 1515056 0.0000 0.598804
(82.68 83.47 84.36 84.93 88.63 86.76 89.24 97.39 88.91	67.14 81.86 83.69 84.95 88.62 86.70 87.70 90.33 90.40	
0/ 0- 9-30 137.0 170.6 187.2	85.0 2.697 15.537 1.460 70347	4106 102090 49304 2000000 1533478 0.0000 0.599631
(82.71 83.49 84.38 84.94 88.68 86.77 89.27 97.52 88.90	67.13 81.85 83.69 84.96 88.67 86.70 87.70 90.37 90.42	
0/ 0- 9-40 136.8 170.3 187.1	85.0 2.704 15.532 1.472 70347	4142 102147 49295 2000000 1551799 0.0000 0.600431
(82.73 83.51 84.40 84.95 88.74 86.78 89.30 97.66 88.90	67.11 81.83 83.69 84.97 88.92 86.70 87.70 90.40 90.44	
0/ 0- 9-50 136.6 170.0 186.9	85.0 2.711 15.526 1.485 70347	4178 102203 49285 2000000 1570021 0.0000 0.601194
(82.76 83.54 84.42 84.96 88.79 86.78 89.34 97.79 88.90	67.09 81.82 83.69 84.98 88.98 86.70 87.70 90.44 90.48	
0/ 0-10+ 0 136.3 169.7 186.7	85.0 2.717 15.521 1.497 70346	4214 102260 49276 2000000 1588446 0.0000 0.601924
(82.78 83.56 84.44 84.97 88.84 86.79 89.35 97.93 88.89	67.08 81.80 83.69 84.99 89.03 86.70 87.70 90.47 90.48	
0/ 0-15+ 0 129.7 161.9 182.0	85.0 2.840 15.348 1.792 70345	5100 104113 49026 2000000 2094845 0.0000 0.612316
(83.47 84.16 84.98 85.26 90.05 87.02 90.09 101.56 88.80	66.80 81.40 83.69 85.26 90.19 86.70 87.70 91.39 91.02	
0/ 0-20+ 0 125.9 156.2 178.2	85.0 2.944 15.249 1.995 70343	5175 106180 48831 2000002 2549244 0.4185 0.626549
(84.03 84.66 85.44 85.51 90.77 87.21 90.75 104.58 88.71	66.64 81.01 83.69 85.51 90.89 86.70 87.70 92.08 91.47	
0/ 0-25+ 0 128.1 151.9 175.0	85.0 3.121 15.306 2.115 70342	6037 108427 48736 2000018 2987945 0.6341 0.649133
(84.58 85.15 85.89 85.77 91.45 87.41 91.37 107.06 88.62	66.53 80.65 83.69 85.77 91.55 86.70 87.70 92.72 91.88	
0/ 0-30+ 0 129.2 148.6 172.2	85.0 3.213 15.335 2.178 70340	6205 110775 48690 2000039 3359991 0.1841 0.655453
(85.11 85.64 86.35 86.04 92.16 87.52 91.93 109.13 88.54	66.46 80.31 83.68 86.04 92.24 86.70 87.70 93.34 92.32	
0/ 0-35+ 0 130.5 146.0 169.7	85.0 3.329 15.371 2.258 70339	6419 110640 48601 2000048 3731007 0.3589 0.666214
(85.64 86.13 86.80 86.32 92.88 87.83 92.47 110.87 88.46	66.40 79.98 83.68 86.32 92.94 86.70 87.70 93.95 92.79	
0/ 0-40+ 0 131.3 143.8 167.5	85.0 3.396 15.391 2.305 70337	6544 110560 48544 2000060 4048480 0.4394 0.674907
(86.16 85.61 87.25 86.60 93.59 88.44 92.97 112.33 88.38	66.36 79.68 83.68 86.60 93.64 86.70 87.70 94.55 93.19	
0/ 0-45+ 0 131.7 142.0 165.5	85.0 3.430 15.400 2.329 70335	6608 110518 48509 2000074 4424100 0.4936 0.676231
(86.66 87.09 87.70 88.68 94.28 88.25 93.45 113.55 88.31	66.33 79.39 83.68 86.88 94.33 86.70 87.70 95.13 93.62	
0/ 0-50+ 0 131.8 140.4 163.8	85.0 3.439 15.403 2.336 70334	6626 110503 48490 2000089 4790951 0.5288 0.677190
(87.14 87.55 88.13 87.16 94.95 88.46 93.90 114.58 88.24	66.31 79.12 83.68 87.16 94.98 86.70 87.70 95.67 94.04	
0/ 0-55+ 0 131.8 139.0 162.1	85.0 3.432 15.401 2.331 70332	6643 110506 48483 2000109 5086935 0.5502 0.676464
(87.60 88.00 88.56 87.43 95.58 88.68 94.34 115.45 88.18	66.29 78.86 83.67 87.43 95.61 86.70 87.70 96.19 94.45	
0/ 1+ 0 131.5 137.8 160.7	85.1 3.412 15.395 2.318 70330	6657 110523 48486 2000122 5373306 0.1664 0.674520
(88.04 88.43 88.96 87.71 96.19 88.88 94.79 116.19 88.12	66.28 78.62 83.67 87.71 96.21 86.70 87.70 96.56 94.84	
0/ 1-15+ 0 130.7 134.8 156.8	85.1 3.343 15.372 2.272 70326	6656 110595 48491 2000165 6244086 0.5115 0.667654
(89.22 89.62 90.10 88.51 97.87 89.49 95.91 117.80 87.95	66.26 77.96 83.67 88.51 97.88 86.69 87.69 98.01 95.93	
0/ 1-30+ 0 129.4 132.3 153.7	85.1 3.228 15.336 2.192 70321	6243 110714 48539 2000210 7056315 0.4844 0.656050
(90.22 90.65 91.10 89.28 99.36 90.57 96.94 118.80 87.80	66.25 77.40 83.66 89.28 99.37 86.69 87.69 99.15 96.99	
0/ 1-45+ 0 127.9 130.2 150.9	85.1 3.105 15.297 2.108 70316	6018 110841 48594 2000252 7622392 0.4462 0.643459
(91.06 91.55 91.98 90.00 100.68 90.61 97.88 119.43 87.67	66.25 75.91 83.66 90.00 100.69 86.69 87.69 100.16 97.70	
0/ 2+ 0 126.5 128.4 148.5	85.1 2.986 15.259 2.027 70311	5803 110965 48647 2000291 8550562 0.4048 0.651202
(91.77 92.31 92.74 90.69 101.87 91.11 98.69 119.83 87.56	66.25 75.49 83.65 90.69 101.87 86.69 87.69 101.06 98.40	
0/ 2-15+ 0 125.1 126.8 146.4	85.1 2.876 15.223 1.954 70307	5605 111080 48695 2000326 9246944 0.3641 0.619288
(92.36 92.96 93.40 91.33 102.93 91.59 99.44 120.09 87.46	66.25 76.12 83.65 91.33 102.93 86.69 87.69 101.88 98.99	
0/ 2-30+ 0 123.9 125.3 144.4	85.1 2.777 15.189 1.888 70302	5428 111186 48735 2000357 9915990 0.3260 0.608493
(92.86 93.52 93.96 91.94 103.88 92.03 100.12 120.24 87.38	66.26 75.79 83.64 91.94 103.88 86.69 87.69 102.65 99.49	
0/ 2-45+ 0 122.7 124.0 142.7	85.1 2.688 15.159 1.830 70298	5271 111281 48767 2000385 10581174 0.2912 0.598707
(93.29 94.00 94.45 92.52 104.74 92.44 100.72 120.34 87.30	66.27 75.50 83.64 92.52 104.74 86.69 87.69 103.37 99.90	

0/ 3= 0= 0	121.7	122.8	141.1	85.1	2,610	15,131	1,779	70293	5133	111368	48793	2000410	11185255	0,2599	0.589912
	(	93.65	94.41	94,88	93.07	105.51	92.83	101.27	120.38	104.39	104.05	100.42	87.24		
		66.28	75.24	83.64	93.07	105.51	86.69	87.69	104.05	100.42	87.19				
0/ 3+15= 0	120.8	121.7	139.6	85.2	2,541	15,106	1,735	70289	5013	111447	48812	2000432	11190471	0,2322	0.582058
	(	93.96	94.76	95.25	93.59	106.20	93.20	101.77	120.39	104.39	104.05	100.42	87.19		
		66.29	75.01	83.64	93.59	106.20	86.69	87.69	104.70	100.42	87.19				
0/ 3+30= 0	120.0	120.7	138.2	85.2	2,480	15,084	1,696	70285	4908	111519	48825	2000452	12378670	0,2076	0.575057
	(	94.23	95.06	95.57	94.08	106.83	93.54	102.21	120.39	104.39	104.05	100.42	87.19		
		66.30	74.81	83.64	94.08	106.83	86.69	87.69	105.32	100.42	87.19				
0/ 3+45= 0	119.3	119.8	136.9	85.2	2,427	15,065	1,662	70281	4816	111585	48833	2000470	12951403	0,1860	0.568829
	(	94.47	95.33	95.85	94.55	107.39	93.86	102.61	120.36	104.36	104.05	100.42	87.11		
		66.32	74.62	83.65	94.55	107.39	86.69	87.69	105.91	100.42	87.11				
0/ 4= 0= 0	118.6	119.0	135.8	85.2	2,380	15,047	1,632	70277	4736	111645	48837	2000486	13509984	0,1870	0.563289
	(	94.68	95.56	96.10	95.00	107.91	94.17	102.98	120.32	104.32	104.05	100.42	87.08		
		66.33	74.45	83.65	95.00	107.91	86.68	87.68	106.47	100.42	87.08				
0/ 4+15= 0	118.1	118.3	134.7	85.2	2,338	15,032	1,607	70272	4666	111700	48837	2000500	14055541	0,1903	0.558362
	(	94.87	95.76	96.32	95.43	108.37	94.46	103.30	120.27	104.27	104.05	100.42	87.06		
		66.35	74.29	83.65	95.43	108.37	86.68	87.68	107.01	101.28	87.06				
0/ 4+30= 0	117.6	117.6	133.7	85.2	2,302	15,018	1,584	70268	4604	111751	48834	2000513	14989053	0,1357	0.553397
	(	95.05	95.94	96.52	95.85	108.79	94.74	103.54	120.22	104.22	104.05	100.42	87.04		
		66.37	74.15	83.66	95.85	108.79	86.68	87.68	107.52	101.39	87.04				
0/ 4+45= 0	117.1	117.0	132.7	85.2	2,270	15,005	1,564	70264	4550	111798	48830	2000525	15111374	0,1231	0.550097
	(	95.21	95.09	96.70	96.24	109.17	95.00	103.86	120.15	104.09	104.05	100.42	87.02		
		66.39	74.02	83.67	96.24	109.17	86.68	87.68	108.01	101.49	87.02				
0/ 5= 0= 0	116.7	116.5	131.8	85.2	2,241	14,994	1,547	70260	4503	111841	48823	2000535	15623257	0,1123	0.546688
	(	95.36	96.24	96.86	96.62	109.51	95.25	104.09	120.09	104.09	104.05	100.42	87.01		
		66.40	73.90	83.66	96.62	109.51	86.68	87.68	108.48	101.57	87.01				
0/ 5+15= 0	116.4	116.0	131.0	85.2	2,217	14,984	1,532	70256	4462	111880	48815	2000545	16125369	0,1030	0.543654
	(	95.50	96.36	97.00	96.99	109.83	95.49	104.31	120.02	104.09	104.05	100.42	87.01		
		66.42	73.79	83.69	96.99	109.83	86.68	87.68	108.92	101.64	87.01				
0/ 5+30= 0	116.1	115.5	130.2	85.2	2,195	14,976	1,519	70252	4426	111915	48806	2000554	16618305	0,0949	0.540556
	(	95.63	96.48	97.14	97.35	110.12	95.72	104.50	119.95	104.09	104.05	100.42	87.00		
		66.44	73.69	83.70	97.35	110.12	86.68	87.68	109.34	101.70	87.00				
0/ 5+45= 0	115.8	115.1	129.5	85.2	2,175	14,968	1,507	70248	4394	111948	48797	2000562	17102599	0,0878	0.538523
	(	95.76	96.59	97.26	97.69	110.38	95.94	104.67	119.88	104.09	104.05	100.42	87.00		
		66.46	73.60	83.72	97.69	110.38	86.68	87.68	109.74	101.75	87.00				
0/ 6= 0= 0	115.6	114.7	128.8	85.3	2,158	14,961	1,497	70244	4366	111979	48787	2000570	17578732	0,0815	0.536356
	(	95.89	96.69	97.38	98.02	110.62	96.15	104.82	119.81	104.09	104.05	100.42	87.01		
		66.48	73.51	83.74	98.02	110.62	86.68	87.68	110.11	101.79	87.01				

A NEW TMAX VALUE MUST BE PLACED AFTER THE VARIABLE DUMP IF THIS PROBLEM IS TO BE CONTINUED.
 THIS IS THE LAST PROBLEM IN THIS SET.

APPENDIX B

FORTRAN 63 Listing of PTHISTRY Code

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PROGRAM PTHISTRY                                MAIN 1
C THIS IS THE MAIN ROUTINE AND IS SO LABELLED.    MAIN 2
C
C THIS CODE IS WRITTEN IN FORTRAN FOR THE CDC-3600 COMPUTER. IT HAS MAIN 5
C BEEN ASSIGNED THE ARGONNE NATIONAL LABORATORY IDENTIFICATION MAIN 6
C NUMBER RE-360X. WITH THIS CODE ONE MAY CALCULATE SECONDARY MAIN 7
C CONTAINMENT OVERPRESSURE, VARIOUS TEMPERATURES, AND VARIOUS MAIN 8
C MATERIAL INVENTORIES AS FUNCTIONS OF TIME FOLLOWING A MAIN 9
C WATER-EXPULSION ACCIDENT IN A REACTOR FACILITY.      MAIN 10
C EQUIVALENCE (COEFAW, COEFAL, COEFAP), (COEFWA, COEFLA, COFP) MAIN 11
C DIMENSION T(25,9),XX(25,9),XK(25,9),X(25,9),CHEAT(25,9), MAIN 12
C XRHO(25,9),NODES(9),XHI(9),XHO(9)                MAIN 13
C
C MAIN PROGRAM FORMAT STATEMENTS                 MAIN 14
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2 FORMAT(120H1.....CONTAINMENT OVERPRESSURE AND RELATED PARAMETERSMAIN 16
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X)                                                 MAIN 18
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X           )                                     MAIN 20
4 FORMAT(1H0,46X,25HINITIAL INPUT INFORMATION//)   MAIN 21
5 FORMAT(10H MAX, TIME,4X,14HFIRST BREAK AT,4X,15HSECOND BREAK AT, MAIN 22
X3X,21HFIRST PRINT INCREMENT,3X,22HSECOND PRINT INCREMENT,3X,   MAIN 23
X21HTHIRD PRINT INCREMENT/F10.0,F18.0,F19.0,F24.3,F25.3,F24.3// MAIN 24
X25X,40HTIME INCREMENTS FOR COMPUTATION PURPOSES,42X,          MAIN 25
X13HOUTPUT OPTION/5X,5HFIRST,14X,6HSECOND,14X,5HTHIRD,15X,       MAIN 26
X6HFOURTH,15X,5HFIFTH,17X,13H******/F10.3,F20.3,F19.3,F21.3, MAIN 27
XF20.3,F30.0///5X,                                         MAIN 28
X5HPOWER,4X,13HTIME AT POWER,4X,17HDECAY HEAT TO AIR,4X,        MAIN 29
X20H.....TO LOWER WATER,5X,20H.....TO UPPPER WATER,4X,           MAIN 30
X19H.....TO POOL WATER/F10.3,F17.3,F21.3,F24.3,F25.3,F23.3// MAIN 31
X17H0START REFRIG, AT,3X,7HREFRIG,,3X,16HREFRIG, FROM AIR,3X,  MAIN 32
X22H.....FROM LOWER WATER,3X,22H.....FROM UPPPER WATER,3X,       MAIN 33
X21H.....FROM POOL WATER/F17.0,F10.0,F19.3,F25.3,F25.3,F24.3// MAIN 34
X20H0END INJECT SPRAY AT,1X,17HINJECT SPRAY RATE,2X,            MAIN 35
X18HINJECT SPRAY TEMP.,2X,20HEND RECIRC. SPRAY AT,2X,           MAIN 36
X18HRECIRC. SPRAY RATE,1X,19HRECIRC. SPRAY TEMP./             MAIN 37
XF20.0,F18.3,F20.3,F22.0,F20.3,F20.3//                      MAIN 38
X22H0COMPUTATION TOLERANCE,11X,25HCONDENSATE TO LOWER WATER,11X, MAIN 39
X20H.....TO UPPPER WATER,12X,19H.....TO POOL WATER/             MAIN 40
XF22.7,F36.3,F31.3,F31.3//                                    MAIN 41
6 FORMAT(21H0ATMOSPHERIC PRESSURE,6X,16HLEAK PARAMETER 1,6X,     MAIN 42
X14H...PARAMETER 2,5X,14H...PARAMETER 3,5X,14H...PARAMETER 4,5X,  MAIN 43
X14H...PARAMETER 5/F21.0,F22.4,F20.4,F19.4,F19.4,F19.4//       MAIN 44
X17H0CONTAINED VOLUME,2X,13HAIR-POOL AREA,3X,                  MAIN 45
X20HAIR-LOWER WATER AREA,1X,20HAIR-UPPER WATER AREA,3X,         MAIN 46
X19HH.T.COEF. AIR-WATER,3X,19HH.T.COEF. WATER-AIR/             MAIN 47
XF17.0,F15.0,F23.0,F21.0,F22.3,F22.3//                      MAIN 48
X50X,19HINITIAL INVENTORIES/14X,3HAIR,15X,11HWATER VAPOR,15X,  MAIN 49
X11HLOWER WATER,15X,11HUPPER WATER,15X,10HPOOL WATER/           MAIN 50
XF17.2,F26.2,F26.2,F25.2//                                    MAIN 51
X50X,20HINITIAL TEMPERATURES/14H CONTAINED AIR,7X,11HLOWER WATER, MAIN 52
X8X,11HUPPER WATER,8X,10HPOOL WATER,8X,18HOUTSIDE ATMOSPHERE,    MAIN 53
X8X,17HSURROUNDING EARTH/F14.3,F18.3,F19.3,F18.3,F26.3,F25.3// MAIN 54
7 FORMAT(1H1,43X,31HCONDUCTING SUBSYSTEM PARAMETERS/5X,          MAIN 55
X6H FIRST,8X,6HSECOND,8X,5HTHIRD,8X,6HFOURTH,8X,5HFIFTH,8X,   MAIN 56
X5HSIXTH,8X,7HSEVENTH,8X,6HEIGHTH,8X,5HNINTH//               MAIN 57
X40X,40HINNER SURFACE HEAT TRANSFER COEFFICIENTS/             MAIN 58
XF11.3,F14.3,F13.3,F14.3,F13.3,F13.3,F15.3,F14.3,F13.3//  MAIN 59
                                         MAIN 60

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X40X,40HOUTER SURFACE HEAT TRANSFER COEFFICIENTS/	MAIN	61
XF11.3,F14.3,F13.3,F14.3,F13.3,F13.3,F15.3,F14.3,F13.3///	MAIN	62
X50X,21HHEAT CONDUCTION AREAS/	MAIN	63
XF11.0,F14.0,F13.0,F14.0,F13.0,F15.0,F14.0,F13.0///	MAIN	64
X50X,20HINITIAL TEMPERATURES/	MAIN	65
XF11.3,F14.3,F13.3,F14.3,F13.3,F13.3,F15.3,F14.3,F13.3)	MAIN	66
8 FORMAT(1H1,51X,15HCOMPUTED OUTPUT/)	MAIN	67
9 FORMAT(13X,23H*****TEMPERATURES*****,2X,19H*****PRESSURES*****,	MAIN	68
X2X,35H*****INVENTORIES*****11X,	MAIN	69
X15H*****RATES*****19X,5HLOWER,1X,5HUPPER,2X,4HPOOL,37X,5HLOWER,	MAIN	70
X3X,5HUPPER,4X,4HPOOL,5X,5HDECAY,1X,7HCONDEN-/5X,4HTIME,6X,3HAIR,	MAIN	71
X1X,5HWATER,1X,5HWATER,1X,5HWATER,3X,4HOVER,4X,3HAIR,1X,5HVAPOR,4X,MAIN	MAIN	72
X3HAIR,2X,5HVAPOR,3X,5HWATER,3X,5HWATER,3X,5HWATER,6X,4HHEAT,1X,	MAIN	73
X6HSATION,2X,7HLEAKAGE//29X,1H(,17X,	MAIN	74
X55HCONDUCTING SUBSYSTEM SURFACE TEMPERATURES - INNER/OUTER/	MAIN	75
X29X,5X,5HFIRST,4X,6HSECOND,5X,5HTHIRD,4X,6HFOURTH,5X,5HFIFTH,	MAIN	76
X5X,5HSIXTH,3X,7HSEVENTH,4X,6HEIGHTH,5X,5HNINTH)//)	MAIN	77
10 FORMAT(1X,I2,1H/,I2,1H-,I2,1H-,I2,F6.1,F6.1,	MAIN	78
XF6.1,F6.1,F7.3,F7.3,F6.3,F7.0,F7.0,F8.0,F8.0,F10.0,F7.4,	MAIN	79
XF9.6/28X,1H(,9F10.2/29X,9F10.2,1H)//	MAIN	80
11 FORMAT(38H THIS IS THE LAST PROBLEM IN THIS SET.)	MAIN	81
12 FORMAT(8X,4HTIME,1X,9HAIR TEMP.,1X,10HOVERPRESS.,2X,7HSECTION,	MAIN	82
X24X,32HINNER TO OUTER NODE TEMPERATURES/)	MAIN	83
13 FORMAT(1X,I2,1H/,I2,1H-,I2,1H-,I2,F10.1,2X,F9.3,5X,1H1,1X,8F10.2/	MAIN	84
X40X,8F10.2/40X,8F10.2/40X,8F10.2)	MAIN	85
14 FORMAT(38X,1H2,1X,8F10.2/40X,8F10.2/40X,8F10.2)	MAIN	86
15 FORMAT(38X,1H3,1X,8F10.2/40X,8F10.2/40X,8F10.2/40X,8F10.2)	MAIN	87
16 FORMAT(38X,1H7,1X,8F10.2/40X,8F10.2/40X,8F10.2/40X,8F10.2)	MAIN	88
17 FORMAT(/)	MAIN	89
18 FORMAT(61I2)	MAIN	90
19 FORMAT(I1)	MAIN	91
20 FORMAT(44HPREVIOUS PROBLEM CONTINUED.....)	MAIN	92
21 FORMAT(92H0A NEW TMAX VALUE MUST BE PLACED AFTER THE VARIABLE DUMPMAIN	MAIN	93
X IF THIS PROBLEM IS TO BE CONTINUED.)	MAIN	94
22 FORMAT(93H0THIS PROBLEM HAS BEEN TERMINATED AT THIS POINT BECAUSE MAIN	MAIN	95
THE OVERPRESSURE HAS BECOME NEGATIVE.)	MAIN	96
23 FORMAT(78H1ALL SUBSYSTEM NODAL TEMPERATURES HAVE BEEN READ IN POINMAIN	MAIN	97
XT-BY=POINT AS FOLLOWS=)	MAIN	98
24 FORMAT(1X,I4,5X,11F10.2/10X,11F10.2/10X,11F10.2)	MAIN	99
25 FORMAT(8HSECTION/)	MAIN	100
C		101
MAIN PROGRAM READ STATEMENTS, HEADINGS, AND INPUT DISPLAY	MAIN	102
100 READ 18, ICNTRL,ITEMP,IPUNCH	MAIN	103
IF(EOP,60)1150,110	MAIN	104
110 IF(ICNTRL-1)120,1080,1130	MAIN	105
120 PRINT 2	MAIN	106
DO 130 I=1,4	MAIN	107
READ 3	MAIN	108
130 PRINT 3	MAIN	109
PRINT 4	MAIN	110
READ 1, TMAX,TBREAK,TBREAK2,TPRINT1,TPRINT2,TPRINT3	MAIN	111
READ 1, DEL1,DEL2,DEL3,DEL4,DEL5,OPTION	MAIN	112
READ 1, POWER,TPOWER,FRACTA,FRACTL,FRACTL2,FRACTP	MAIN	113
READ 1, RSTART,REFRIG,FRIGA,FRIGL,FRIGL2,FRIGP	MAIN	114
READ 1, SPTIME,SPRATE,SPTEMP,RSPTIME,RSPRATE,RSPTEMP	MAIN	115
READ 1, TLRNCE,PARTL,PARTL2,PARTP	MAIN	116
READ 1, POUT,FL1,FL2,FL3,FL4,FL5	MAIN	117
READ 1, VOLUME,AREAAP,AREALA,AREAL2A,COEFAW,COEFWA	MAIN	118
READ 1, WAIR,WVAPOR,WLIQD,WLIQD2,WPOOL	MAIN	119
READ 1, TEMPA,TEMPL,TEMPL2,TEMPP,TEMPG	MAIN	120

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READ 1, (XHI(I),I=1,9)                                MAIN 121
READ 1, (XHO(I),I=1,9)                                MAIN 122
READ 1, AREA1,AREA2,AREA3,AREA4,AREA5,AREA6          MAIN 123
READ 1, AREA7,AREA8,AREA9                            MAIN 124
READ 1, TEMP1,TEMP2,TEMP3,TEMP4,TEMP5,TEMP6          MAIN 125
READ 1, TEMP7,TEMP8,TEMP9                            MAIN 126
PRINT 5, TMAX,TBREAK,TBREAK2,TPRINT1,TPRINT2,TPRINT3,  MAIN 127
X      DEL1,DEL2,DEL3,DEL4,DEL5,OPTION,                MAIN 128
X      POWER,TPOWER,FRACTA,FRACTL,FRACTL2,FRACTP,    MAIN 129
X      RSTART,REFRIG,FRIGA,FRIGL,FRIG_2,FRIGP,        MAIN 130
X      SPTIME,SPRATE,SPTEMP,RSPTIME,RSPRATE,RSPTEMP,  MAIN 131
X      TLRNCE,PARTL,PAHL2,PARTP                      MAIN 132
PRINT 6, POUT,FL1,FL2,FL3,FL4,FL5,                  MAIN 133
X      VOLUME,AREAAP,AREALA,AREAL2A,COEFAW,COEFWA,   MAIN 134
X      WAIR,WVAPOR,WLIQD,WLIQD2,WPOOL,               MAIN 135
X      TEMPA,TEMLT,TEML2,TEMPP,TPROUT,TEMPG          MAIN 136
PRINT 7, (XHI(I),I=1,9),                           MAIN 137
X      (XHO(I),I=1,9),                               MAIN 138
X      AREA1,AREA2,AREA3,AREA4,AREA5,AREA6,          MAIN 139
X      AREA7,AREA8,AREA9,                            MAIN 140
X      TEMP1,TEMP2,TEMP3,TEMP4,TEMP5,TEMP6,          MAIN 141
X      TEMP7,TEMP8,TEMP9                            MAIN 142
DO 140 I=1,9                                         MAIN 143
C
C      CONDUCTING SUB-SYSTEMS INPUT READ IN AND DISPLAYED BY SUBROUTINE
C      GOMTRY
140 CALL GOMTRY(I,NODES,XX,XK,X,CHEAT,RHO)
C
C      L1=NODES(1)                                     MAIN 144
L2=NODES(2)                                     MAIN 145
L3=NODES(3)                                     MAIN 146
L4=NODES(4)                                     MAIN 147
L5=NODES(5)                                     MAIN 148
L6=NODES(6)                                     MAIN 149
L7=NODES(7)                                     MAIN 150
L8=NODES(8)                                     MAIN 151
L9=NODES(9)                                     MAIN 152
C
C      INITIAL NODAL TEMPERATURES READ IN AS CONSTANTS FOR EACH
C      CONDUCTING SUB-SYSTEM                         MAIN 153
DO 150 J=1,L1                                     MAIN 154
150 T(J,1)=TEMP1                                  MAIN 155
DO 160 J=1,L2                                     MAIN 156
160 T(J,2)=TEMP2                                  MAIN 157
DO 170 J=1,L3                                     MAIN 158
170 T(J,3)=TEMP3                                  MAIN 159
DO 180 J=1,L4                                     MAIN 160
180 T(J,4)=TEMP4                                  MAIN 161
DO 190 J=1,L5                                     MAIN 162
190 T(J,5)=TEMP5                                  MAIN 163
DO 200 J=1,L6                                     MAIN 164
200 T(J,6)=TEMP6                                  MAIN 165
DO 210 J=1,L7                                     MAIN 166
210 T(J,7)=TEMP7                                  MAIN 167
DO 220 J=1,L8                                     MAIN 168
220 T(J,8)=TEMP8                                  MAIN 169
DO 230 J=1,L9                                     MAIN 170
230 T(J,9)=TEMP9                                  MAIN 171
IF(ITEMP)>250,250,240                           MAIN 172
                                         MAIN 173
                                         MAIN 174
                                         MAIN 175
                                         MAIN 176
                                         MAIN 177
                                         MAIN 178
                                         MAIN 179
                                         MAIN 180

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C INITIAL NODAL TEMPERATURES READ IN POINT-BY-POINT FOR ALL MAIN 181
C CONDUCTING SUB-SYSTEMS AND DISPLAYED FOR EDITING PURPOSE - - - MAIN 182
C PREVIOUS INITIAL NODAL TEMPERATURES ARE OVERRIDDEN MAIN 183
C
240 READ 1, (T(J,1),J=1,L1) MAIN 184
    READ 1, (T(J,2),J=1,L2) MAIN 185
    READ 1, (T(J,3),J=1,L3) MAIN 186
    READ 1, (T(J,4),J=1,L4) MAIN 187
    READ 1, (T(J,5),J=1,L5) MAIN 188
    READ 1, (T(J,6),J=1,L6) MAIN 189
    READ 1, (T(J,7),J=1,L7) MAIN 190
    READ 1, (T(J,8),J=1,L8) MAIN 191
    READ 1, (T(J,9),J=1,L9) MAIN 192
    PRINT 23 MAIN 193
    PRINT 25 MAIN 194
    PRINT 24, 1,(T(J,1),J=1,L1) MAIN 195
    PRINT 24, 2,(T(J,2),J=1,L2) MAIN 196
    PRINT 24, 3,(T(J,3),J=1,L3) MAIN 197
    PRINT 24, 4,(T(J,4),J=1,L4) MAIN 198
    PRINT 24, 5,(T(J,5),J=1,L5) MAIN 199
    PRINT 24, 6,(T(J,6),J=1,L6) MAIN 200
    PRINT 24, 7,(T(J,7),J=1,L7) MAIN 201
    PRINT 24, 8,(T(J,8),J=1,L8) MAIN 202
    PRINT 24, 9,(T(J,9),J=1,L9) MAIN 203
250 CONTINUE MAIN 204
C
C HEADINGS PRINTED FOR COMPUTED OUTPUT MAIN 205
    PRINT 8 MAIN 206
    IF(OPTION=2,)260,270,280 MAIN 207
260 PRINT 9 MAIN 208
    GO TO 290 MAIN 209
270 PRINT 12 MAIN 210
    GO TO 290 MAIN 211
280 PRINT 9 MAIN 212
    PRINT 12 MAIN 213
290 CONTINUE MAIN 214
C
C VARIABLE INITIALIZATION MAIN 215
    KGATE=0 MAIN 216
    L=1 MAIN 217
    M=0 MAIN 218
    TIME=0. MAIN 219
    TPRINT=TPRINT1 MAIN 220
    TWRITE=0. MAIN 221
    W=0. MAIN 222
    W2=0. MAIN 223
    WCOND=0. MAIN 224
    WP=0. MAIN 225
    Y=0. MAIN 226
    Z=1. MAIN 227
    CALL LIQDE(TEMP1,EL11) MAIN 228
    CALL LIQDE(TEMP12,EL21) MAIN 229
    CALL LIQDE(TEMPP,EP1) MAIN 230
    CALL AIR(TEMPA,CVAIR) MAIN 231
    EA1=CVAIR*TEMPA MAIN 232
    CALL VAPORE(TEMPA,EV1) MAIN 233
    CALL LIQDE(SPTEMP,ES1) MAIN 234
    CALL LIQDE(RSPTEMP,RES1) MAIN 235
C
C BEGINNING OF MAIN PROGRAM COMPUTATIONS MAIN 236
    
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300 IF(TIME-TBREAK2)320,310,320          MAIN 241
310 DEL4=DELS      MAIN 242
   Z=2.      MAIN 243
C
C   CORE AFTERHEAT COMPUTED FOR THE TIME INTERVAL      MAIN 244
320 CALL DECAYE(TIME,TPOWER,PCOWER,DEL1,DEL2,DEL3,TBREAK,DEL4,DELTIM,      MAIN 245
   XENERGY)      MAIN 246
   TIMDEL=TIME+DELTIM      MAIN 247
C
C   SPRAY AND REFRIGERATION COMPUTATIONS      MAIN 248
IF(TIME-SPTIME)340,330,330      MAIN 249
330 SPRATE=0.      MAIN 250
340 WSPRAY=8.3*SPRATE*DELTIM      MAIN 251
   IF(TIME-RSPTIME)360,350,350      MAIN 252
350 RSPRATE=0.      MAIN 253
360 RWSPRAY=A.3*RSPRATE*DELTIM      MAIN 254
   WLIQD=WLIQD-RWSPRAY      MAIN 255
   IF(TIME-RSTART)370,380,380      MAIN 256
370 QREFRG=0.      MAIN 257
   GO TO 390      MAIN 258
380 QREFRG=DELTIM*REFRIG      MAIN 259
390 CONTINUE      MAIN 260
   N=1      MAIN 261
C
C   DETERMINATION OF WATER AND AIR PROPERTIES BASED ON TEMPERATURES AT      MAIN 262
C BEGINNING OF TIME INTERVAL      MAIN 263
CALL VAPORE(TEMP1,EVTEML)      MAIN 264
CALL VAPORE(TEMP2,EVTEML2)      MAIN 265
CALL VAPORE(TEMP1,EVTEMP)      MAIN 266
CALL VAPORP(TEMP1,PSAT)      MAIN 267
CALL VAPORP(TEMP2,PSAT2)      MAIN 268
CALL VAPORP(TEMP1,PSATP)      MAIN 269
CALL AIR(TEMPA,CVAIR)      MAIN 270
CALL LIQDE(TEMPA,ELTEMA)      MAIN 271
CALL LIQDE(TEMPA,EL2TEMA)      MAIN 272
CALL VAPORE(TEMPA,EVTEMA)      MAIN 273
C
C   DETERMINATION OF VAPOR PRESSURE AND AMOUNT OF WATER EVAPORATED      MAIN 274
C BASED ON TEMPERATURES AT BEGINNING OF TIME INTERVAL      MAIN 275
PVAPR=.5959027778*(WVAPOR*,5*(W+W2+WP-WCOND))*(TEMPA+459.69)/VOLUNMAIN 276
XE
   IF(PSAT-PVAPR)400,400,410      MAIN 277
400 W=0.      MAIN 278
   GO TO 420      MAIN 279
410 W=4.3333333E-5*((PSAT-PVAPR)**1.2)*AREALA*DELTIM      MAIN 280
420 IF(PSATP-PVAPR)430,430,440      MAIN 281
430 WP=0.      MAIN 282
   GO TO 450      MAIN 283
440 WP=4.3333333E-5*((PSATP-PVAPR)**1.2)*AREAAP*DELTIM      MAIN 284
450 IF(PSAT2-PVAPR)460,460,470      MAIN 285
460 W2=0.      MAIN 286
   GO TO 480      MAIN 287
470 W2=4.3333333E-5*((PSAT2-PVAPR)**1.2)*AREAL2A*DELTIM      MAIN 288
480 CONTINUE      MAIN 289
   CALL LIQDE(TEMPA,ES2)      MAIN 290
   CALL LIQDE(TEMPA,RES2)      MAIN 291
C
C   DETERMINATION OF HEAT TRANSFERRED BETWEEN SUB-SYSTEMS DURING TIME      MAIN 292
C INTERVAL BASED ON TEMPERATURES AT BEGINNING OF TIME INTERVAL      MAIN 293
GAIRS=WSPRAY*(ES2-ES1)      MAIN 294
                                         MAIN 295
                                         MAIN 296
                                         MAIN 297
                                         MAIN 298
                                         MAIN 299
                                         MAIN 300

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RQAIRS=RWSPRAY*(RES2-RES1)
CAIR1=(XHI(1)/3600.)*AREA1*(TEMPA-T(1,1))*DELTIM
CAIR2=(XHI(2)/3600.)*AREA2*(TEMPA-T(1,2))*DELTIM
CAIR3=(XHI(3)/3600.)*AREA3*(TEMPA-T(1,3))*DELTIM
CAIR4=(XHI(4)/3600.)*AREA4*(TEMPA-T(1,4))*DELTIM
CAIR5=(XHI(5)/3600.)*AREA5*(TEMPA-T(1,5))*DELTIM
CAIR6=(XHI(6)/3600.)*AREA6*(TEMPA-T(1,6))*DELTIM
CAIR8=(XHO(8)/3600.)*AREA8*(TEMPA-T(LB,B))*DELTIM
CAIR9=(XHO(9)/3600.)*AREA9*(TEMPA-T(L9,9))*DELTIM
IF(TEMPA-TEMPP)500,490,490
490 CAIRP=(COEFAP/3600.)*AREAAP*(TEMPA-TEMPP)*DELTIM
GO TO 510
500 CAIRP=(COEFPA/3600.)*AREAAP*(TEMPP-TEMPA)*DELTIM
510 QPOOL9=(XHI(9)/3600.)*AREA9*(TEMPP-T(1,9))*DELTIM
CLIQD7=(XHI(7)/3600.)*AREA7*(TEML-T(1,7))*DELTIM
CLIQD8=(XHI(8)/3600.)*AREA8*(TEML2-T(1,8))*DELTIM
IF(TEMPA-TEMPL)530,520,520
520 GAIROL=(COEFLA/3600.)*AREALA*(TEMPA-TEMPL)*DELTIM
GO TO 540
530 GAIROL=(COEFLA/3600.)*AREALA*(TEMPL-TEMPA)*DELTIM
540 IF(TEMPA-TEMPL2)560,550,550
550 GAIROL2=(COEFLA/3600.)*AREAL2A*(TEMPA-TEMPL2)*DELTIM
GO TO 570
560 GAIROL2=(COEFLA/3600.)*AREAL2A*(TEMPL2-TEMPA)*DELTIM
570 CONTINUE
      EL12=(WLIQD*EL11-QLIQD7*QAIHL+FRACTL*ENERGY-W*EVTEML-QREFRG*FRIGL+MAIN
      XWCOND*ELTEMA*PARTL+.1850281397*(PARTL*WCOND)*(VOLUME/WVAPOR)*PVAPRMAIN 326
      X)/(WLIQD-W*WCOND*PARTL)
      EL22=(WLIQD2*EL21-QLIQD8+GAIROL2+FRACTL2*ENERGY
      X                                         *W2*EVTEML2-QREFRG*FRIGL2*WCOND* MAIN 328
      XELTEMA*PARTL2+.1850281397*(PARTL2*WCOND)*(VOLUME/WVAPOR)*PVAPR)/ MAIN 331
      X(WLIQD2-W2*WCOND*PARTL2)
      EP2=(WPOLL*EP1+QAIRP-QPOOL9=WP*EVTEMP-QREFRG*FRIGP+FRACTP*ENERGY+ MAIN 332
      XWCOND*ELTEMA*PARTP+.1850281397*(PARTP*WCOND)*(VOLUME/WVAPOR)*PVAPRMAIN 334
      X)/(WPOLL-WP*WCOND*PARTP)                                           MAIN 335
      MAIN 336

DETERMINATION OF NEW LIQUID AND GAS SUB-SYSTEM TEMPERATURES
AT END OF TIME INTERVAL
CALL VATERT(EL12,BLIQD)
CALL VATERT(EL22,BLIQD2)
CALL VATERT(EP2,BPOOL)
EA2=(WAIR*EA1+WVAPOR*EV1-(QAIROL+QAIROL2+QAIRP+QAIROS+QAIR1+QAIR2+
XQAIROS+
XQAIRO3+QAIRO4+QAIRO5+QAIRO6+QAIRO8+QAIRO9)-(WVAPOR+W*W2*WP)          MAIN 343
X*EV1+FRACTA*ENERGY+W*EVTEML*W2*EVTEML2+NP*EVTEMP-QREFRG*FRIGA+WCONMAIN 344
XD*(EVTEMA-ELTEMA)+.1850281397*(W*W2*WP-WCOND)*(VOLUME/WVAPOR)*PVAPR/ MAIN 345
XPVAPR)/WAIR
BAIR=EA2/CVAIR
CALL AIR(BAIR,CVAIR)

DETERMINATION OF SIMPLE AVERAGE LIQUID AND GAS SUB-SYSTEM
TEMPERATURES DURING TIME INTERVAL
BLIQD=(TEMPL+BLIQD)/2,
BLIQD2=(TEMPL2+BLIQD2)/2,
DPOOL=(TEMPP+BPOOL)/2,
DAIR=(TEMPA+BAIR)/2,
580 BB=BLIQD2
CC=BLIOD
DD=BAIR
EE=BPOOL

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C ALL COMPUTATIONS THROUGH STATEMENT 810 ARE REPETITIVE BUT ARE MAIN 361
 C BASED ON AVERAGE TEMPERATURES DURING TIME INTERVAL MAIN 362
 CALL VAPORE(DAIR,EV2) MAIN 363
 CALL VAPORE(DLIQD,EVTEML) MAIN 364
 CALL VAPORE(DLIQD2,EVTEML2) MAIN 365
 CALL VAPORE(DPOOL,EVTEMP) MAIN 366
 CALL LIQDE(DAIR,ES2) MAIN 367
 CALL LIQDE(DAIR,RES2) MAIN 368
 QAIRS=WSPRAY*(ES2-ES1) MAIN 369
 RQAIRS=RWSPRAY*(RES2-RES1) MAIN 370
 QAIR1=(XHI(1)/3600.)*AREA1*(DAIR-T(1,1))*DELTIM MAIN 371
 QAIR2=(XHI(2)/3600.)*AREA2*(DAIR-T(1,2))*DELTIM MAIN 372
 QAIR3=(XHI(3)/3600.)*AREA3*(DAIR-T(1,3))*DELTIM MAIN 373
 QAIR4=(XHI(4)/3600.)*AREA4*(DAIR-T(1,4))*DELTIM MAIN 374
 QAIR5=(XHI(5)/3600.)*AREA5*(DAIR-T(1,5))*DELTIM MAIN 375
 QAIR6=(XHI(6)/3600.)*AREA6*(DAIR-T(1,6))*DELTIM MAIN 376
 QAIR8=(XHO(8)/3600.)*AREA8*(DAIR-T(L8,8))*DELTIM MAIN 377
 QAIR9=(XHO(9)/3600.)*AREA9*(DAIR-T(L9,9))*DELTIM MAIN 378
 IF(DAIR-DPOOL)600,590,590 MAIN 379
 590 QAIRP=(COEFAP/3600.)*AREAAP*(DAIR-DPOOL)*DELTIM MAIN 380
 GO TO 610 MAIN 381
 600 QAIRP=(COEFPA/3600.)*AREAAP*(DPOOL-DAIR)*DELTIM MAIN 382
 610 QPOOL9=(XHI(9)/3600.)*AREA9*(DPOOL-T(1,9))*DELTIM MAIN 383
 QLIQD7=(XHI(7)/3600.)*AREA7*(DLIQD-T(1,7))*DELTIM MAIN 384
 QLIQD8=(XHI(8)/3600.)*AREA8*(DLIQD2-T(1,8))*DELTIM MAIN 385
 IF(DAIR-DLIQD)630,620,620 MAIN 386
 620 CAIRL=(COEFLA/3600.)*AREALA*(DAIR-DLIQD)*DELTIM MAIN 387
 GO TO 640 MAIN 388
 630 CAIRL=(COEFLA/3600.)*AREALA*(DLIQD-DAIR)*DELTIM MAIN 389
 640 IF(DAIR-DLIQD2)660,650,650 MAIN 390
 650 CAIRL2=(COEFLA/3600.)*AREAL2A*(DAIR-DLIQD2)*DELTIM MAIN 391
 GO TO 670 MAIN 392
 660 CAIRL2=(COEFLA/3600.)*AREAL2A*(DAIR-DLIQD2)*DELTIM MAIN 393
 670 CONTINUE MAIN 394
 CALL VAPORP(DLIQD,PSAT) MAIN 395
 CALL VAPORP(DLIQD2,PSAT2) MAIN 396
 CALL VAPORP(DPOOL,PSATP) MAIN 397
 PVAPR=.5959027778*(WVAPOR+.5*(W+W2+WP-WCOND))*(DAIR+459.69)/VOLUME MAIN 398
 IF(PSAT-PVAPR)680,680,690 MAIN 399
 680 W=0. MAIN 400
 GO TO 700 MAIN 401
 690 W=4.33333333E-5*((PSAT-PVAPR)**1.2)*AREALA*DELTIM MAIN 402
 700 IF(PSATP-PVAPR)710,710,720 MAIN 403
 710 WP=0. MAIN 404
 GO TO 730 MAIN 405
 720 WP=4.33333333E-5*((PSATP-PVAPR)**1.2)*AREAAP*DELTIM MAIN 406
 730 IF(PSAT2-PVAPR)740,740,750 MAIN 407
 740 W2=0. MAIN 408
 GO TO 760 MAIN 409
 750 W2=4.33333333E-5*((PSAT2-PVAPR)**1.2)*AREAL2A*DELTIM MAIN 410
 760 CONTINUE MAIN 411
 CALL VAPORE(DAIR,EVTEMA) MAIN 412
 CALL LIQDE(DAIR,ELTEMA) MAIN 413
 QAIRS=WSPRAY*(ELTEMA-ES1) MAIN 414
 RQAIRS=RWSPRAY*(ELTEMA-RES1) MAIN 415
 EL12=(WLIQD*EL11-QLIQD7+QAIRL+FRACTL*ENERGY-W*EVTEML-QREFRG*FRIGL+MAIN 416
 XWCOND*ELTEMA*PARTL+.1850281397*(PARTL*WCOND)*(VOLUME/WVAPOR)*PVAPR MAIN 417
 X)/(WLIQD-W*WCOND*PARTL) MAIN 418
 EL22=(WLIQD2*EL21-QLIQD8+QAIRL2+FRACTL2*ENERGY-W2*EVTEML-QREFRG* MAIN 419
 EL22*(WLIQD2*EL21-QLIQD8+QAIRL2+FRACTL2*ENERGY-W2*EVTEML-QREFRG* MAIN 420

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XFRIGL2+WCOND*ELTEMA*PARTL2*,1850281397*(PARTL2*WCOND)*(VOLUME/
XWVAPOR)*PVAPR)/(WL1QD2-W2*WCOND*PARTL2) MAIN 421
EP2=(WPOOL+EP1+QAIRP-QPOOL9-WP*EVTEMP-QREFRG*FRIGP+FRACTP*ENERGY* MAIN 422
XWCOND*ELTEMA*PARTP+,1850281397*(PARTP*WCOND)*(VOLUME/WVAPOR)*PVAPRMAIN 423
X)/(WPOOL-WP+WCOND*PARTP) MAIN 424
CALL VATERT(EL12,BLIQD) MAIN 425
CALL VATERT(EL22,BLIQD2) MAIN 426
CALL VATERT(EP2,BPOOL) MAIN 427
CALL AIR (BAIR,CVAIR) MAIN 428
EA2=(WAIR*EA1+WVAPOR*EV1-(QAIRL+QAIRL2+QAIRP+QAIRS+QAIR1+QAIR2+ MAIN 429
XQAIRS+ MAIN 430
XQAIR3+QAIR4+QAIR5+QAIR6+QAIR8+QAIR9)-(WVAPOR+W-W2*WP) MAIN 431
X*EV1+FRACTA*ENERGY+W*EVTEML*W2*EVTEML2+WP*EVTEMP-QREFRG*FRIGA+WCONMAIN 433
XD*(EVTEMA-ELTEMA)+.1850281397*(W-W2*WP-WCOND)*(VOLUME/WVAPOR)* MAIN 434
XPVAPR)/WAIR MAIN 435
BAIR=EA2/CVAIR MAIN 436
CALL AIR(BAIR,CVAIR) MAIN 437

C CONVERGENCE CHECK ON AIR AND WATER TEMPERATURES MAIN 438
IF(ABSF((EE-BPOOL)/BPOOL)=TLRNCE)770,770,800 MAIN 439
770 IF(ABSF((CC-BLIQD)=BLIQD)=TLRNCE)780,780,800 MAIN 440
780 IF(ABSF((DD+BAIR)/BAIR)=TLRNCE)790,790,800 MAIN 441
790 IF(ABSF((BB-BLIQD2)=BLIQD2)=TLRNCE)820,820,800 MAIN 442
800 BLIQD=(TEMPL+(CC+BLIQD)/2,)/2, MAIN 443
BLIQD2=(TEMPL2+(BB+BLIQD2)/2,)/2, MAIN 444
CPOOL=(TEMPP+(EE+BPOOL)/2,)/2, MAIN 445
CAIR=(TEMPP*(DD+BAIR)/2,)/2, MAIN 446
N=N+1 MAIN 447
IF(N=10)580,580,810 MAIN 448
810 CONTINUE MAIN 449
GO TO 100 MAIN 450

C DETERMINATION OF TOTAL CONDENSATION MAIN 451
820 CONTINUE MAIN 452
CALL VAPORP(BAIR,SATRD) MAIN 453
WSATRD=(SATRD*VOLUME)/( .5959027778*(BAIR+459.69)) MAIN 454
IF(WSATRD-WVAPOR=W-W2*WP+WCOND)830,870,870 MAIN 455
830 J=1 MAIN 456
CALL VAPORP(BAIR,PS1) MAIN 457
T2=BAIR+3. MAIN 458
CALL VAPORP(T2,PS2) MAIN 459
BTWO=(PS2-PS1)/3, MAIN 460
ATWO=PS1-BTWO*BAIR MAIN 461
CALL VAPORE(BAIR,V1) MAIN 462
CALL VAPORE(T2,V2) MAIN 463
CALL LIQDE(BAIR,XL1) MAIN 464
CALL LIQDE(T2,XL2) MAIN 465
BONE=((V2-XL2)-(V1-XL1))/3, MAIN 466
AONE=V1-XL1-BONE*BAIR MAIN 467
840 A=(WAIR*CVAIR+(WVAPOR+W+WP)*.36)+BONE*(WVAPOR+W+WP)-(144./85.81)*MAIN 468
XBONE*BTWO*VOLUME MAIN 469
B=BAIR*(WAIR*CVAIR+(WVAPOR+W+WP)*.36)-459.69*(WAIR*CVAIR+(WVAPOR+WMAIN 470
X+WP)*.36)+AONE*(WVAPOR+W+WP)-(144./85.81)*AONE*BTWO*VOLUME*BONE* MAIN 471
X459.69*(WVAPOR+W+WP)-(144./85.81)*ATWO*BONE*VOLUME MAIN 472
C=BAIR*(WAIR*CVAIR+(WVAPOR+W+WP)*.36)+459.69*AONE*459.69*(WVAPOR+WMAIN 473
X+WP)-(144./85.81)*AONE*ATWO*VOLUME MAIN 474
Q=B**2-4.*A*C MAIN 475
BAIR2=(-B-SQRTF(Q))/(2.*A) MAIN 476
IF(J=1)850,850,860 MAIN 477
850 T3=BAIR2-0.5 MAIN 478

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T4=T3+1.
CALL VAPORP(T3,PS1)
CALL VAPORP(T4,PS2)
BTWO=PS2-PS1
ATWO=PS1-BTWO*T3
CALL VAPORE(T3,V1)
CALL VAPORE(T4,V2)
CALL LIQDE(T3,XL1)
CALL LIQDE(T4,XL2)
BONE=(V2-XL2)-(V1-XL1)
AONE=V1-XL1-BONE*T3
J=2
GO TO 840
860 WCOND=((WVAPOR+W+WP)*(BAIR2+459.69)-(144./85.81)*(ATWO+BTWO*BAIR2))MAIN 494
X*VOLUME/(BAIR2+459.69)
BAIR=BAIR2
GO TO 880
870 WCOND=0.
880 CONTINUE
IF(WCOND)870,890,890
890 IF(SDEL-DELTIM)900,930,900
900 IF(KGATE)920,910,920
910 KGATE=1
GO TO 300
920 KGATE=0
930 CONTINUE
CONDEL=WCOND/DELTIM

C DETERMINATION OF VARIOUS PRESSURES
PAIR=.370138889*WAIR*(TEMPA+459.69)/VOLUME MAIN 509
PVAPR=.5959027778*WVAPOR*(TEMPA+459.69)/VOLUME MAIN 510
P=PVAPR+PAIR
POVER=P-POUT
ENERGY=ENERGY*(FRACTA+FRACTL+FRACTL2+FRACTP) MAIN 513
IF(POVER)940,940,950
950 FLEAKR=FL1+FL2*(POVER*FL3)+FL4*(POVER**FL5) MAIN 521
FLEAK=(FLEAKR*DELTIM)/8640000.
960 WW=(W+W2+WP)/DELTIM
IF(Z=2)980,970,1010
970 TPRINT=TPRINT3
Z=3.
GO TO 1010
980 IF(L=2)990,1010,1010
990 IF(TIME-TBREAK)1010,1000,1000
1000 TPRINT=TPRINT2
L=2
1010 IF(TIME-TWRITE)1090,1020,1020
1020 DAYS=TIME/86400.
IDAYS=DAYS
HOURS=24.*(DAYS-IDAYS) + (2.75E-7)
IHOURS=HOURS
XMIN=60.*(HOURS-IHOURS)
MIN=XMIN
SEC=60.*(XMIN-MIN)
ISEC=SEC

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IF(OPTION=2,)1030,1040,1050          MAIN 541
C
C   OPTION 1 PRINTOUT OF COMPUTED RESULTS    MAIN 542
1030 PRINT 10, IDAYS,IHOURS,MIN,ISEC,TEMPA,TEMLP,TEMLP2,TEMPP,    MAIN 543
XPOVER,PAIR,PVAPR,WAIR,WVAPOR,WLIQD,WLIQD2,WPOOL,Y,CONDEL,    MAIN 544
XFLEAKR,(T(1,I),I=1,9),T(L1,1),T(L2,2),T(L3,3),T(L4,4),T(L5,5),    MAIN 545
XT(L6,6),T(L7,7),T(L8,8),T(L9,9)    MAIN 546
GO TO 1060    MAIN 547
C
C   OPTION 2 PRINTOUT OF COMPUTED RESULTS    MAIN 548
1040 PRINT 13, IDAYS,IHOURS,MIN,ISEC,TEMPA,P0VER,(T(I531,1),I531=1,L1)    MAIN 549
PRINT 14, (T(I531,2),I531=1,L2)    MAIN 550
PRINT 15, (T(I531,3),I531=1,L3)    MAIN 551
PRINT 16, (T(I531,7),I531=1,L7)    MAIN 552
PRINT 17    MAIN 553
GO TO 1060    MAIN 554
C
C   OPTION 3 PRINTOUT OF COMPUTED RESULTS (COMBINATION OF OPTIONS    MAIN 555
C   1 AND 2)    MAIN 556
1050 PRINT 10, IDAYS,IHOURS,MIN,ISEC,TEMPA,TEMLP,TEMLP2,TEMPP,    MAIN 557
XPOVER,PAIR,PVAPR,WAIR,WVAPOR,WLIQD,WLIQD2,WPOOL,Y,CONDEL,    MAIN 558
XFLEAKR,(T(1,I),I=1,9),T(L1,1),T(L2,2),T(L3,3),T(L4,4),T(L5,5),    MAIN 559
XT(L6,6),T(L7,7),T(L8,8),T(L9,9)    MAIN 560
PRINT 13, IDAYS,IHOURS,MIN,ISEC,TEMPA,P0VER,(T(I531,1),I531=1,L1)    MAIN 561
PRINT 14, (T(I531,2),I531=1,L2)    MAIN 562
PRINT 15, (T(I531,3),I531=1,L3)    MAIN 563
PRINT 16, (T(I531,7),I531=1,L7)    MAIN 564
PRINT 17    MAIN 565
1060 CONTINUE    MAIN 566
TWRITE=TWRITE+TPRINT    MAIN 567
IF(P0VER+.005)1070,1090,1090    MAIN 568
1070 PRINT 22    MAIN 569
GO TO 100    MAIN 570
C
C   PROBLEM CONTINUATION RESTART ON RESTART OPTION 1 (ALLOWABLE    MAIN 571
C   MACHINE TIME EXHAUSTED)    MAIN 572
1080 PRINT 20    MAIN 573
READ 18, I,I531,IDAYS,IHOURS,ISEC,J,KGATE,L,L1,L2,L3,L4,L5,L6,L7,MAIN 574
XL8,L9,M,MIN,NODES    MAIN 575
READ 1, A,AONE,AREA1,AREA2,AREA3,AREA4,AREA5,AREA6,AREA7,AREA8,    MAIN 576
XAREA9,AREAAP,AREAL2,AREAL3,ATWO,B,BAIR,BAIR2,BB,BLIQD,BLIQD2,    MAIN 577
XBONE,BPOOL,BTWO,C,CC,(CHEAT(I,1),I=1,L1),(CHEAT(I,2),I=1,L2),    MAIN 578
X(CHEAT(I,3),I=1,L3),(CHEAT(I,4),I=1,L4),(CHEAT(I,5),I=1,L5),    MAIN 579
X(CHEAT(I,6),I=1,L6),(CHEAT(I,7),I=1,L7),(CHEAT(I,8),I=1,L8),    MAIN 580
X(CHEAT(I,9),I=1,L9),COEFAL,COEFAP,COEFAW,COEFLA,COEFPA,COEFWA,    MAIN 581
XCONDEN,CAIR,DAIR,DAYS,DD,DEL1,DEL2,DEL3,DEL4,DEL5,DELTIM,DLIQD,    MAIN 582
XDLIQD2,DPOOL,EA1,EA2,EE,EL11,EL12,EL21,EL22,EL2TEMA,ELTEMA,ENERGY,MAIN 583
XEP1,EP2,ES1,ES2,EV1,EV2,EVTEMA,EVTEML2,EVTEMP,FL1,FL2,FL3    MAIN 584
READ 1, FL4,FL5,FLEAK,FLEAKR,FRACTA,FRACTL,FRACTL2,FRACTP,FRIGA,    MAIN 585
XFRIGL,FRIGL2,FRIGP,HOURS,OPTION,P,PAIR,PARTL,PARTL2,PARTP,POUT,    MAIN 586
XPOVER,POWER,PS1,PS2,PSAT,PSAT2,PSATP,PVAPR,Q,QAIR1,QAIR2,QAIR3,    MAIN 587
XCAIR4,QAIR5,QAIR6,QAIR8,QAIR9,QAIRL,QAIRL2,QAIRP,QAIRS,QLIQD7,    MAIN 588
XGLIQD8,QPOOL9,QREFRG,REFRIG,RES1,RES2,(RHO(I,1),I=1,L1),    MAIN 589
X(RHO(I,2),I=1,L2),(RHO(I,3),I=1,L3),(RHO(I,4),I=1,L4),    MAIN 590
X(RHO(I,5),I=1,L5),(RHO(I,6),I=1,L6),(RHO(I,7),I=1,L7),    MAIN 591
X(RHO(I,8),I=1,L8),(RHO(I,9),I=1,L9),QAIRS,RSPRATE,RSPTEMP,    MAIN 592
XRSPTIME,RSTART,RWSPRAY,SATURD,SDEL,SEC,SPRATE,SPTEMP,SPTIME    MAIN 593
READ 1, (T(I,1),I=1,L1),(T(I,2),I=1,L2),(T(I,3),I=1,L3),    MAIN 594
X(T(I,4),I=1,L4),(T(I,5),I=1,L5),(T(I,6),I=1,L6),(T(I,7),I=1,L7),    MAIN 595
X(T(I,8),I=1,L8),(T(I,9),I=1,L9),T2,T3,T4,TBREAK,TBREAK2,TEMP1,    MAIN 596
MAIN 597
MAIN 598
MAIN 599
MAIN 600

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XTEMP2, TEMP3, TEMP4, TEMP5, TEMP6, TEMP7, TEMP8, TEMP9, TEMPA, TEMPG, TEMPL, MAIN 601
XTEMPL2, TEMPP, TIMDEL, TIME, TLRNCE, TMAX, TMPOUT, TPOWER, TPRINT, TPRINT1, MAIN 602
XTPRINT2, TPRINT3, TWRITE, V1, V2, VOLUME, W, W2, WAIR, WCOND, WLQD, WLQD2, MAIN 603
XWP, WPPOOL, WSATRD, WSPRAY, WVAPUR, WW, (X(I,1), I=1,L1), (X(I,2), I=1,L2), MAIN 604
X(X(I,3), I=1,L3), (X(I,4), I=1,L4), (X(I,5), I=1,L5), (X(I,6), I=1,L6), MAIN 605
X(X(I,7), I=1,L7), (X(I,8), I=1,L8), (X(I,9), I=1,L9), XHI, XHO MAIN 606
    READ 1, (XK(I,1), I=1,L1), (XK(I,2), I=1,L2), (XK(I,3), I=1,L3), MAIN 607
X(XK(I,4), I=1,L4), (XK(I,5), I=1,L5), (XK(I,6), I=1,L6), MAIN 608
X(XK(I,7), I=1,L7), (XK(I,8), I=1,L8), (XK(I,9), I=1,L9), XL1, XL2, XMN, MAIN 609
X(XX(I,1), I=1,L1), (XX(I,2), I=1,L2), (XX(I,3), I=1,L3), MAIN 610
X(XX(I,4), I=1,L4), (XX(I,5), I=1,L5), (XX(I,6), I=1,L6), MAIN 611
X(XX(I,7), I=1,L7), (XX(I,8), I=1,L8), (XX(I,9), I=1,L9), Y, Z MAIN 612
1090 CONTINUE MAIN 613
    IF(TIMELEFT(1).LT.5000)1100,1120 MAIN 614
1100 IF(IPUNCH)1110,1110,1190 MAIN 615
C MAIN 616
C VARIABLE DUMP FOR RESTART ON RESTART OPTION 1 (ALLOWABLE MACHINE MAIN 617
C TIME EXHAUSTED) MAIN 618
1110 PUNCH 18, 1,ITEMP,IPUNCH MAIN 619
PUNCH 18, I,1531,1DAYS,IHOURS,ISEC,J,KGATE,L,L1,L2,L3,L4,L5,L6,L7,MAIN 620
XL8,L9,M,MIN,N,NODES MAIN 621
PUNCH 1, A,AONE,AREA1,AREA2,AREA3,AREA4,AREA5,AREA6,AREA7,AREA8, MAIN 622
XAREA9,AREAAP,AREAL2A,AREAL2A,ATWO,B,BAIR,BAIR2,BB,BLIQD,BLIQD2, MAIN 623
XBONE,BPOOL,BTWO,C,CC,(CHEAT(I,1),I=1,L1),(CHEAT(I,2),I=1,L2), MAIN 624
X(CHEAT(I,3),I=1,L3),(CHEAT(I,4),I=1,L4),(CHEAT(I,5),I=1,L5), MAIN 625
X(CHEAT(I,6),I=1,L6),(CHEAT(I,7),I=1,L7),(CHEAT(I,8),I=1,L8), MAIN 626
X(CHEAT(I,9),I=1,L9),COEFAL,COEFAP,COEFAW,COEFLA,COEFP,COEFWA, MAIN 627
XCONDEN,CVAIR,DAIR,DAYS,DD,DEL1,DEL2,DEL3,DEL4,DEL5,DELTIM,DLIQD, MAIN 628
XDLIQD2,DPPOOL,EA1,EA2,EE,EL1,EL12,EL21,EL22,EL2TEMA,ELTEMA,ENERGY, MAIN 629
XEP1,EP2,ES1,ES2,EV1,EV2,EVTEMA,EVTEML,EVTEML2,EVTEMP,FL1,FL2,FL3 MAIN 630
PUNCH 1, FL4,FL5,FLEAK,FLEAKR,FRACTA,FRACTL,FRACTL2,FRACTP,FRIGA, MAIN 631
XFRIGL,FRIGL2,FRIGP,HOURS,OPTION,P,PAIR,PARL,PARTL2,PARP,POUT, MAIN 632
XPOVER,POWER,PS1,PS2,PSAT,PSAT2,PSATP,VPAPR,Q,QAIR1,QAIR2,QAIR3, MAIN 633
XQAIR4,QAIR5,QAIR6,QAIR8,QAIR9,QAIRL,QAIRL2,QAIRP,QAIRS,QLIQD7, MAIN 634
XCLIQD8,QPOOL9,QREFRG,REFRIG,RES1,RES2,(RHO(I,1),I=1,L1), MAIN 635
X(RHO(I,2),I=1,L2),(RHO(I,3),I=1,L3),(RHO(I,4),I=1,L4), MAIN 636
X(RHO(I,5),I=1,L5),(RHO(I,6),I=1,L6),(RHO(I,7),I=1,L7), MAIN 637
X(RHO(I,8),I=1,L8),(RHO(I,9),I=1,L9),RQAIRS,RSPRATE,RSPTEMP, MAIN 638
XRSPTIME,RSTART,RWSPRAY,SATUD,SDEL,SEC,SPRATES,SPTEMP,SPTIME MAIN 639
PUNCH 1, (T(I,1),I=1,L1),(T(I,2),I=1,L2),(T(I,3),I=1,L3), MAIN 640
X(T(I,4),I=1,L4),(T(I,5),I=1,L5),(T(I,6),I=1,L6),(T(I,7),I=1,L7), MAIN 641
X(T(I,8),I=1,L8),(T(I,9),I=1,L9),T2,T3,T4,TBREAK,TBREAK2,TEMP1, MAIN 642
XTEMP2,TEMP3,TEMP4,TEMP5,TEMP6,TEMP7,TEMP8,TEMP9,TEMPA,TEMPG,TEMPL, MAIN 643
XTEMPL2,TEMPP,TIMDEL,TIME,TLRNCE,TMAX,TMPOUT,TPOWER,TPRINT,TPRINT1,MAIN 644
XTPRINT2,TPRINT3,TWRITE,V1,V2,VOLUME,W,W2,WAIR,WCOND,WLQD,WLQD2, MAIN 645
XWP,WPPOOL,WSATRD,WSPRAY,WVAPUR,WW,(X(I,1),I=1,L1),(X(I,2),I=1,L2), MAIN 646
X(X(I,3),I=1,L3),(X(I,4),I=1,L4),(X(I,5),I=1,L5),(X(I,6),I=1,L6), MAIN 647
X(X(I,7),I=1,L7),(X(I,8),I=1,L8),(X(I,9),I=1,L9),XHI,XHO MAIN 648
    PUNCH 1, (XK(I,1),I=1,L1),(XK(I,2),I=1,L2),(XK(I,3),I=1,L3), MAIN 649
X(XK(I,4),I=1,L4),(XK(I,5),I=1,L5),(XK(I,6),I=1,L6), MAIN 650
X(XK(I,7),I=1,L7),(XK(I,8),I=1,L8),(XK(I,9),I=1,L9),XL1,XL2,XMIN, MAIN 651
X(XX(I,1),I=1,L1),(XX(I,2),I=1,L2),(XX(I,3),I=1,L3), MAIN 652
X(XX(I,4),I=1,L4),(XX(I,5),I=1,L5),(XX(I,6),I=1,L6), MAIN 653
X(XX(I,7),I=1,L7),(XX(I,8),I=1,L8),(XX(I,9),I=1,L9),Y,Z MAIN 654
    GO TO 1190 MAIN 655
C MAIN 656
C DETERMINATION OF NEW CONDUCTING SUB-SYSTEM NODAL TEMPERATURES MAIN 657
1120 CONTINUE MAIN 658
    CALL CONDU(1,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPA,BAIR, MAIN 659
XTMPOUT,TMPOUT,T) MAIN 660

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CALL CONDUC(2,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPA,BAIR, MAIN 661
XTEMPOUT,TEMPOUT,T) MAIN 662
CALL CONDUC(3,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPA,BAIR, MAIN 663
XTEMPG,TEMPG,T) MAIN 664
CALL CONDUC(4,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPA,BAIR, MAIN 665
XTEMPA,BAIR,T) MAIN 666
CALL CONDUC(5,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPA,BAIR, MAIN 667
XTEMPA,BAIR,T) MAIN 668
CALL CONDUC(6,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPA,BAIR, MAIN 669
XTEMPG,TEMPG,T) MAIN 670
CALL CONDUC(7,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEML,BLIQD, MAIN 671
XTEMPG,TEMPG,T) MAIN 672
CALL CONDUC(8,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPL2,BLIQD2, MAIN 673
X,TEMPA,BAIR,T) MAIN 674
CALL CONDUC(9,DELTIM,NODES,X,XX,XK,XHI,XHO,CHEAT,RHO,TEMPP,BPOOL, MAIN 675
XTEMPA,BAIR,T) MAIN 676
X) MAIN 677
INVENTORY ADJUSTMENTS AND INITIALIZATION FOR COMPUTATIONS IN MAIN 678
NEXT TIME INTERVAL MAIN 679
Y=Y+ENERGY MAIN 680
WAIR=WAIR*(1.-FLEAK) MAIN 681
WVAPOR=(WVAPOR+W*W2*WP-WCOND)*(1.-FLEAK) MAIN 682
WLIQD=WLIQD-W+WCOND*PARTL MAIN 683
WLIQD2=WLIQD2-W2*WCOND*PARTL2 MAIN 684
WPOOL=WPOOL-WP+WCOND*PARTP MAIN 685
TEML=BLIQD MAIN 686
TEMPL2=BLIQD2 MAIN 687
TEMPL=(TEMPL*WLIQD+DAIR*WSPRAY+DAIR*RWSPRAY)/(WLIQD*WSPRAY+RWSPRAY) MAIN 688
X) MAIN 689
VOLUME=VOLUME-.1337*SPrATE*DELTIM MAIN 690
WLIQD=WLIQD*WSPRAY+RWSPRAY MAIN 691
TEMPP=BPOOL MAIN 692
TEMPA=BAIR MAIN 693
EA1=EA2 MAIN 694
EV1=EV2 MAIN 695
EL11=EL12 MAIN 696
EL21=EL22 MAIN 697
EP1=EP2 MAIN 698
SDEL=DELTIM MAIN 699
M=0 MAIN 700
GO TO 1140 MAIN 701
C
C PROBLEM CONTINUATION RESTART ON RESTART OPTION 2 (PROBLEM MAIN 702
C COMPLETED) MAIN 703
1130 PRINT 20 MAIN 704
READ 18, I,I531,IDAYS,IHOURS,ISEC,J,KGATE,L,L1,L2,L3,L4,L5,L6,L7,MAIN 705
XL8,L9,M,MIN,N,NODES MAIN 706
READ 1, A,AONE,AREA1,AREA2,AREA3,AREA4,AREA5,AREA6,AREA7,AREA8, MAIN 707
XAREA9,AREAAP,AREAL2A,AREALA,ATWO,B,BAIR,BAIR2,BB,BLIQD,BLIQD2, MAIN 708
XBONE,BPOOL,BTWO,C,CC,(CHEAT(I,1),I=1,L1),(CHEAT(I,2),I=1,L2), MAIN 709
X(CHEAT(I,3),I=1,L3),(CHEAT(I,4),I=1,L4),(CHEAT(I,5),I=1,L5), MAIN 710
X(CHEAT(I,6),I=1,L6),(CHEAT(I,7),I=1,L7),(CHEAT(I,8),I=1,L8), MAIN 711
X(CHEAT(I,9),I=1,L9),COEFAL,COEFAP,COEFLA,COEFP,COEFWA, MAIN 712
XCONDEL,CVAIR,DAIR,DAYS,DD,DELL1,DEL2,DEL3,DEL4,DEL5,DELTIM,DLIQD, MAIN 713
XDLIQD2,DPOOL,EA1,EA2,EE,EL11,EL12,EL21,EL22,EL2TEMA,ELTEMA,ENERGY,MAIN 714
XEP1,EP2,ES1,ES2,EV1,EV2,EVTEMA,EVTEML,EVTEML2,EVTEMP,FL1,FL2,FL3 MAIN 715
READ 1, FL4,FL5,FLEAK,FLEAKR,FRACTA,FRACTL,FRACTL2,FRACTP,FRIGA, MAIN 716
XFRIGL,FRIGL2,FRIGP,HOURS,OPTION,P,PAIR,PARTL,PARTL2,PARTP,POUT, MAIN 717
XPOVER,POWER,PS1,PS2,PSAT,PSATP,PVAPR,Q,QAIR1,QAIR2,QAIR3, MAIN 718
XQAIR4,QAIR5,QAIR6,QAIR8,QAIR9,QAIRL,QAIRL2,QAIRP,QAIRS,QLIQD7, MAIN 719
XQAIR4,QAIR5,QAIR6,QAIR8,QAIR9,QAIRL,QAIRL2,QAIRP,QAIRS,QLIQD7, MAIN 720

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XCLIQD8,QPOOL9,QREFRG,REFRIG,RES1,RES2,(RHO(I,1),I=1,L1),
X(RHO(I,2),I=1,L2),(RHO(I,3),I=1,L3),(RHO(I,4),I=1,L4),
X(RHO(I,5),I=1,L5),(RHO(I,6),I=1,L6),(RHO(I,7),I=1,L7),
X(RHO(I,8),I=1,L8),(RHO(I,9),I=1,L9),RQAIRS,RSPRATE,RSPTEMP,
XRSPTIME,RSTART,RWSPRAY,SATURD,SDEL,SEC,SPRATE,SPTEMP,SPTIME
  READ 1, (T(I,1),I=1,L1),(T(I,2),I=1,L2),(T(I,3),I=1,L3),
X((I,4),I=1,L4),(T(I,5),I=1,L5),(T(I,6),I=1,L6),(T(I,7),I=1,L7), MAIN 721
X(T(I,8),I=1,L8),(T(I,9),I=1,L9),T2,T3,T4,TBREAK,TBREAK2,TEMP1, MAIN 722
XTEMP2,TEMP3,TEMP4,TEMP5,TEMP6,TEMP7,TEMP8,TEMP9,TEMPA,TEMPG,TEMPL,MAIN 723
XTEMPL2,TEMPP,TIMDEL,TIME,TLNCE,TMAX,TMPOUT,TPOWER,TPRINT,TPRINT1,MAIN 724
XTPRINT2,TPRINT3,TWRITE,V1,V2,VOLUME,W,W2,WAIR,WCOND,WLIQD,WLIQD2, MAIN 725
XWP,WPOOL,WSATRD,WSPRAY,WVAPUR,WW,(X(I,1),I=1,L1),(X(I,2),I=1,L2), MAIN 726
X(X(I,3),I=1,L3),(X(I,4),I=1,L4),(X(I,5),I=1,L5),(X(I,6),I=1,L6), MAIN 727
X((I,7),I=1,L7),(X(I,8),I=1,L8),(X(I,9),I=1,L9),XHI,XHO MAIN 728
  READ 1, (XK(I,1),I=1,L1),(XK(I,2),I=1,L2),(XK(I,3),I=1,L3), MAIN 729
X(XK(I,4),I=1,L4),(XK(I,5),I=1,L5),(XK(I,6),I=1,L6), MAIN 730
X(XK(I,7),I=1,L7),(XK(I,8),I=1,L8),(XK(I,9),I=1,L9),XL1,XL2,XMIN, MAIN 731
X(XX(I,1),I=1,L1),(XX(I,2),I=1,L2),(XX(I,3),I=1,L3), MAIN 732
X((X(I,4),I=1,L4),(XX(I,5),I=1,L5),(XX(I,6),I=1,L6), MAIN 733
X((X(I,7),I=1,L7),(XX(I,8),I=1,L8),(XX(I,9),I=1,L9),Y,Z MAIN 734
  READ 1, TMAX MAIN 735
1140 IF(TIME-TMAX)1180,1160,1160 MAIN 736
1150 PRINT 11 MAIN 737
  GO TO 1190 MAIN 738
1160 IF(IPUNCH)1170,1170,100 MAIN 739
C
C      VARIABLE DUMP FOR RESTART ON RESTART OPTION 2 (PROBLEM
C      COMPLETED)
1170 PUNCH 18, 2,ITEMP,IPUNCH MAIN 740
PUNCH 18, I,I531,IIDAYS,IHOURS,ISEC,J,KGATE,L,L1,L2,L3,L4,L5,L6,L7,MAIN 741
XL8,L9,M,MIN,N,NODES MAIN 742
PUNCH 1, A,AONE,AREA1,AREA2,AREA3,AREA4,AREA5,AREA6,AREA7,AREA8, MAIN 743
XAREA9,AREAAP,AREAL2A,AREALA,ATWO,B,BAIR,BAIR2,BB,BLIQD,BLIQD2, MAIN 744
XBONE,BPOOL,BTWO,C,CC,(CHEAT(I,1),I=1,L1),(CHEAT(I,2),I=1,L2),
X(CHEAT(I,3),I=1,L3),(CHEAT(I,4),I=1,L4),(CHEAT(I,5),I=1,L5), MAIN 745
X(CHEAT(I,6),I=1,L6),(CHEAT(I,7),I=1,L7),(CHEAT(I,8),I=1,L8), MAIN 746
X(CHEAT(I,9),I=1,L9),COEFAL,COEFAP,COEFAN,COEFLA,COEFPA,COEFWA, MAIN 747
XCONDEL,CVAIR,DAIR,DAYS,DD,DEL1,DEL2,DEL3,DEL4,DEL5,DELTIM,DLIQD, MAIN 748
XCLIQD2,DPOOL,EA1,EA2,EE1,EL11,EL12,EL21,EL22,EL2TEMA,ELTEMA,ENERGY,MAIN 749
XEP1,EP2,ES1,ES2,EV1,EV2,EVTEMA,EVTEML,EVTEML2,EVTEMP,FL1,FL2,FL3 MAIN 750
PUNCH 1, FL4,FL5,FLEAK,FLEAKR,FRACTA,FRACTL,FRACTL2,FRACP,FRIGA, MAIN 751
XFRIGL,FRIGL2,FRIGP,HOURS,OPTION,P,PAIR,PAIRL,PAIRL2,PARTP,PARTP,POUT, MAIN 752
XPOVER,POWER,PS1,PS2,PSAT,PSAT2,PSATP,PVAPR,Q,QAIR1,QAIR2,QAIR3, MAIN 753
XQAIR4,QAIR5,QAIR6,QAIR8,QAIR9,QAIRL,QAIRL2,QAIRP,QAIRS,QLIQD7, MAIN 754
XCLIQD8,QPOOL9,QREFRG,REFRIG,RES1,RES2,(RHO(I,1),I=1,L1), MAIN 755
X(RHO(I,2),I=1,L2),(RHO(I,3),I=1,L3),(RHO(I,4),I=1,L4), MAIN 756
X(RHO(I,5),I=1,L5),(RHO(I,6),I=1,L6),(RHO(I,7),I=1,L7), MAIN 757
X(RHO(I,8),I=1,L8),(RHO(I,9),I=1,L9),RQAIRS,RSPRATE,RSPTEMP, MAIN 758
XRSPTIME,RSTART,RWSPRAY,SATURD,SDEL,SEC,SPRATE,SPTEMP,SPTIME
  PUNCH 1, (T(I,1),I=1,L1),(T(I,2),I=1,L2),(T(I,3),I=1,L3), MAIN 759
X(T(I,4),I=1,L4),(T(I,5),I=1,L5),(T(I,6),I=1,L6),(T(I,7),I=1,L7), MAIN 760
X(T(I,8),I=1,L8),(T(I,9),I=1,L9),T2,T3,T4,TBREAK,TBREAK2,TEMP1, MAIN 761
XTEMP2,TEMP3,TEMP4,TEMP5,TEMP6,TEMP7,TEMP8,TEMP9,TEMPA,TEMPG,TEMPL,MAIN 762
XTEMPL2,TEMPP,TIMDEL,TIME,TLNCE,TMAX,TMPOUT,TPOWER,TPRINT,TPRINT1,MAIN 763
XTPRINT2,TPRINT3,TWRITE,V1,V2,VOLUME,W,W2,WAIR,WCOND,WLIQD,WLIQD2, MAIN 764
XWP,WPOOL,WSATRD,WSPRAY,WVAPUR,WW,(X(I,1),I=1,L1),(X(I,2),I=1,L2), MAIN 765
X(X(I,3),I=1,L3),(X(I,4),I=1,L4),(X(I,5),I=1,L5),(X(I,6),I=1,L6), MAIN 766
X((X(I,7),I=1,L7),(X(I,8),I=1,L8),(X(I,9),I=1,L9),XHI,XHO MAIN 767
  PUNCH 1, (XK(I,1),I=1,L1),(XK(I,2),I=1,L2),(XK(I,3),I=1,L3), MAIN 768
X(XK(I,4),I=1,L4),(XK(I,5),I=1,L5),(XK(I,6),I=1,L6), MAIN 769

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X(XK(I,7),I=1,L7),(XK(I,8),I=1,L8),(XK(I,9),I=1,L9),XL1,XL2,XMIN, MAIN 781
X(XX(I,1),I=1,L1),(XX(I,2),I=1,L2),(XX(I,3),I=1,L3), MAIN 782
X(XX(I,4),I=1,L4),(XX(I,5),I=1,L5),(XX(I,6),I=1,L6), MAIN 783
X(XX(I,7),I=1,L7),(XX(I,8),I=1,L8),(XX(I,9),I=1,L9),Y,Z MAIN 784
PRINT 21 MAIN 785
GO TO 100 MAIN 786
1180 TIME=TIME+DELTIM MAIN 787
GO TO 300 MAIN 788
1190 END MAIN 789

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SUBROUTINE DECAYE(TIME,TPOWER,POWER,DEL1,DEL2,DEL3,TBREAK,DEL4,	SUB1	1
XDELTIM,ENERGY)	SUB1	2
SUBROUTINE DECAYE IS LABELLED SUB1.	SUB1	3
C	SUB1	4
THIS SUBROUTINE COMPUTES THE TOTAL CORE AFTERHEAT BASED ON THE	SUB1	5
EQUATIONS OF SHURE REPORTED IN WAPD-BT-24, DECEMBER 1961 AND ALSO	SUB1	6
BASED ON A CONSTANT SHUTDOWN MARGIN OF TEN DOLLARS AND A	SUB1	7
ONE-GROUP DELAYED NEUTRON DECAY CONSTANT OF 0.08 INVERSE SEC,	SUB1	8
DOLRS=-10.	SUB1	9
XLAMDA=.08	SUB1	10
IF(TIME-10.)100,110,110	SUB1	11
100 DELTIM=DEL1	SUB1	12
GO TO 160	SUB1	13
110 IF(TIME-150.)120,130,130	SUB1	14
120 DELTIM=DEL2	SUB1	15
GO TO 160	SUB1	16
130 IF(TIME-TBREAK)140,150,150	SUB1	17
140 DELTIM=DEL3	SUB1	18
GO TO 160	SUB1	19
150 DELTIM=DEL4	SUB1	20
160 CONTINUE	SUB1	21
IF(TIME+TPOWER-10.)170,180,180	SUB1	22
170 ALRGE2=12.05	SUB1	23
ASMLL2=.0639	SUB1	24
GO TO 230	SUB1	25
180 IF(TIME+TPOWER-150.)190,200,200	SUB1	26
190 ALRGE2=15.31	SUB1	27
ASMLL2=.1807	SUB1	28
GO TO 230	SUB1	29
200 IF(TIME+TPOWER-4.E+6)210,220,220	SUB1	30
210 ALRGE2=26.02	SUB1	31
ASMLL2=.2834	SUB1	32
GO TO 230	SUB1	33
220 ALRGE2=53.18	SUB1	34
ASMLL2=.3350	SUB1	35
230 CONTINUE	SUB1	36
IF(TIME-10.)240,250,250	SUB1	37
240 ALARGE=12.05	SUB1	38
ASMALL=.0639	SUB1	39
GO TO 300	SUB1	40
250 IF(TIME-150.)260,270,270	SUB1	41
260 ALARGE=15.31	SUB1	42
ASMALL=.1807	SUB1	43
GO TO 300	SUB1	44
270 IF(TIME-4.E+6)280,290,290	SUB1	45
280 ALARGE=26.02	SUB1	46
ASMALL=.2834	SUB1	47
GO TO 300	SUB1	48

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290 ALARGE=.53,18          SUB1 50
ASMALL=.3350              SUB1 51
300 CONTINUE                SUB1 52
IF(TIME)>310,310,320      SUB1 53
310 ENERGY=4.74*POWER*((ALARGE/(1.-ASMALL))*((TIME+DELTIM)**(1.-ASMALL))*
SUB1 54
X)-(ALRG2/(1.-ASMLL2))*((TPOWER+TIME)
SUB1 55
X*DELTIM)**(1.-ASMLL2))+(TPOWER*TIME)
SUB1 56
X*((POWER)/(XLAMDA*DOLRS))*EXP(((DOLRS)/(1.-DOLRS))*XLAMDA*TIME)
SUB1 57
X*(EXP(((DOLRS)/(1.-DOLRS))*XLAMDA*DELTIM)-1.)*948,
SUB1 58
GO TO 330                 SUB1 59
320 ENERGY=4.74*POWER*((ALARGE/(1.-ASMALL))*((TIME+DELTIM)**(1.-ASMALL))*
SUB1 60
X)-TIME***(1.-ASMALL)-(ALRG2/(1.-ASMLL2))*((TPOWER+TIME)
SUB1 61
X*DELTIM)***(1.-ASMLL2)+(TPOWER*TIME)***(1.-ASMLL2))
SUB1 62
X*((POWER)/(XLAMDA*DOLRS))*EXP(((DOLRS)/(1.-DOLRS))*XLAMDA*TIME)
SUB1 63
X*(EXP(((DOLRS)/(1.-DOLRS))*XLAMDA*DELTIM)-1.)*948,
SUB1 64
330 CONTINUE                SUB1 65
RETURN                     SUB1 66
END                         SUB1 67

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SUBROUTINE AIR(T,CVAIR)           SUB2 1
C
C
SUBROUTINE AIR IS LABELLED SUB2,          SUB2 2
C
C
THIS SUBROUTINE COMPUTES THE SPECIFIC HEAT OF AIR AT CONSTANT          SUB2 5
VOLUME AS A FUNCTION OF AIR TEMPERATURE BASED ON EQUATIONS FOUND          SUB2 6
IN MARKS MECHANICAL ENGINEERS HANDBOOK, SIXTH EDITION.          SUB2 7
CVAIR=(.7809/28.966)*(9.47-(3470./(T+459.69))+((1.16E+6)/
SUB2 8
X((T+459.69)**2))+(.2095/28.966)*(11.515-(172./(SQRTF(T+459.69)))+
SUB2 9
X(1530./(T+459.69)))+(.124*.0093*39.944)/(28.966)+(.0003/28.966)*
SUB2 10
X(16.2-((6530.)/(T+459.69))+(1.41E+6)/((T+459.69)**2))
SUB2 11
CVAIR=CVAIR/1.4
SUB2 12
RETURN                     SUB2 13
END                         SUB2 14

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SUBROUTINE VAPORP(T,P)           SUB3 1
C
C
SUBROUTINE VAPORP IS LABELLED SUB3,          SUB3 2
C

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C
C
THIS SUBROUTINE COMPUTES SATURATED VAPOR PRESSURE AS A          SUB3 5
FUNCTION OF TEMPERATURE BASED ON TABULATED DATA FOUND IN          SUB3 6
THERMODYNAMIC PROPERTIES OF STEAM BY KEENAN AND KEYES.          SUB3 7
IF(T<85.5)100,110,110          SUB3 8

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100 A=.02417539          SUB3 9
B=.08465312          SUB3 10
C=.2703485           SUB3 11
D=.2195277           SUB3 12
E=.1797027           SUB3 13
F=.1708731           SUB3 14
G=0.                  SUB3 15
GO TO 240             SUB3 16
110 IF(T<139.5)120,130,130          SUB3 17
120 A=.01193160          SUB3 18
B=.2093636            SUB3 19
C=-.02603714          SUB3 20
D=.4395907            SUB3 21
E=.2417208            SUB3 22
F=.02164112           SUB3 23
G=.05093223           SUB3 24
GO TO 240             SUB3 25

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130 IF(T=193.5)140,150,150
140 A=-.01187381
  B=.4485902
  C=.5425678
  D=.1.021192
  E=.2138547
  F=.2520024
  G=0.
  GO TO 240
150 IF(T=295.)160,170,170
160 A=-4,231999
  B=.887448
  C=-3,172441
  D,.5012808
  E,.3793918
  F=.1435097
  G=0.
  GO TO 240
170 IF(T=407.5)180,190,190
180 A=-14.57343
  B=19.59562
  C=-7,391896
  D=.02079436
  E=.8624144
  F=.07780033
  G=0.
  GO TO 240
190 IF(T=680.)200,210,210
200 A=280.5484
  B=-149.5451
  C=14,80700
  D=1.414460
  E=1.026224
  F=-.07139038
  G=.01170262
  GO TO 240
210 IF(T=700.)220,220,230
220 A=2708.1
  B=18.42
  C=.056
  D=1.33333333E-4
  E=0.
  GO TO 250
230 A=3093.7
  B=20.6
  C=.075
  D=-8.33333333E-3
  E,.009453781
  GO TO 260
240 P=A*B*((T/100.,)+C*((T/100.,)**2)+D*((T/100.,)**3)
  X+E*((T/100.,)**4)+F*((T/100.,)**5)+G*((T/100.,)**6)
  GO TO 270
250 P=A*B*(T=680.)+C*(T=680.)*(T=685.)+D*(T=680.)*(T=685.)*(T=690.)
  X+E*(T=680.)*(T=685.)*(T=690.)*(T=695.)
  GO TO 270
260 P=A*B*(T=700.)*C*(T=700.)*(T=702.)*D*(T=700.)*(T=702.)*(T=704.)
  X+E*(T=700.)*(T=702.)*(T=704.)*(T=705.)
270 CONTINUE
  RETURN
END
SUB3 26
SUB3 27
SUB3 28
SUB3 29
SUB3 30
SUB3 31
SUB3 32
SUB3 33
SUB3 34
SUB3 35
SUB3 36
SUB3 37
SUB3 38
SUB3 39
SUB3 40
SUB3 41
SUB3 42
SUB3 43
SUB3 44
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SUB3 68
SUB3 69
SUB3 70
SUB3 71
SUB3 72
SUB3 73
SUB3 74
SUB3 75
SUB3 76
SUB3 77
SUB3 78
SUB3 79
SUB3 80
SUB3 81
SUB3 82
SUB3 83
SUB3 84
SUB3 85

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SUBROUTINE LIQDE(T,EE)
C
C SUBROUTINE LIQDE IS LABELLED SUB4.
C
C THIS SUBROUTINE COMPUTES INTERNAL ENERGY OF THE SATURATED LIQUID
C AS A FUNCTION OF TEMPERATURE BASED ON TABULATED DATA FOUND IN
C THERMODYNAMICS OF STEAM BY KEENAN AND KEYES.
C
IF(T=164.27)100,110,110
100 A=-32.157043
      B=98.451312
      C=16.313224
      D=-48.063060
      E=67.936589
      F=-51.343109
      G=19.966374
      H=-3.1374424
      GO TO 260
110 IF(T=260.115)120,130,130
120 A=-35.708961
      B=97.067080
      C=15.189880
      D=-12.444977
      E=2.2341660
      F=1.4200021
      G=.68265020
      H=.084642863
      GO TO 260
130 IF(T=304.355)140,150,150
140 A=-32.869821
      B=104.08264
      C=-3.8178531
      D=1.2177092
      E=-.10515164
      F=0.
      G=0.
      H=0.
      GO TO 260
150 IF(T=333.08)160,170,170
160 A=-17.806760
      B=99.655683
      C=-1.9722080
      D=-1.3907856
      E=.43728834
      F=.14011073
      G=.035575411
      H=0.
      GO TO 260
170 IF(T=354.94)180,190,190
180 A=-14.907106
      B=87.376828
      C=2.4713517
      D=0.
      E=0.
      F=0.
      G=0.
      H=0.
      GO TO 260
190 IF(T=390.825)200,210,210
200 A=217.44911
      B=-84.493634
      SUB4 1
      SUB4 2
      SUB4 3
      SUB4 4
      SUB4 5
      SUB4 6
      SUB4 7
      SUB4 8
      SUB4 9
      SUB4 10
      SUB4 11
      SUB4 12
      SUB4 13
      SUB4 14
      SUB4 15
      SUB4 16
      SUB4 17
      SUB4 18
      SUB4 19
      SUB4 20
      SUB4 21
      SUB4 22
      SUB4 23
      SUB4 24
      SUB4 25
      SUB4 26
      SUB4 27
      SUB4 28
      SUB4 29
      SUB4 30
      SUB4 31
      SUB4 32
      SUB4 33
      SUB4 34
      SUB4 35
      SUB4 36
      SUB4 37
      SUB4 38
      SUB4 39
      SUB4 40
      SUB4 41
      SUB4 42
      SUB4 43
      SUB4 44
      SUB4 45
      SUB4 46
      SUB4 47
      SUB4 48
      SUB4 49
      SUB4 50
      SUB4 51
      SUB4 52
      SUB4 53
      SUB4 54
      SUB4 55
      SUB4 56
      SUB4 57
      SUB4 58
      SUB4 59
      SUB4 60

```

```

C=28.694554          SUB4   61
D=7.2720732         SUB4   62
E=-2.3628823        SUB4   63
F=.27406403         SUB4   64
G=-.050955233       SUB4   65
H=.0062919738        SUB4   66
GO TO 260            SUB4   67
210 IF(T=469.04)220,230,230          SUB4   68
220 A=166.42093        SUB4   69
B=-14.849193         SUB4   70
C=9.4172306          SUB4   71
D=3.4741554          SUB4   72
E=-.048578805        SUB4   73
F=-.070065567        SUB4   74
G=-.019760210        SUB4   75
H=.0036123745        SUB4   76
GO TO 260            SUB4   77
230 IF(T=609.025)240,250,250          SUB4   78
240 A=75.459218         SUB4   79
B=31.095959          SUB4   80
C=12.606874          SUB4   81
D=-.00067623573       SUB4   82
E=-.14633297         SUB4   83
F=.021474211          SUB4   84
G=-.0051103038        SUB4   85
H=.000555580420       SUB4   86
GO TO 260            SUB4   87
250 A=88066.872          SUB4   88
B=-28142.491          SUB4   89
C=-579.17011          SUB4   90
D=299.96199          SUB4   91
E=231.71417          SUB4   92
F=-50.594613          SUB4   93
G=2.7984803          SUB4   94
H=0.                  SUB4   95
260 EE=A*B*((T/100.)*C*((T/100.))**2)+D*((T/100.))**3
X+E*((T/100.))**4+F*((T/100.))**5+G*((T/100.))**6
X+H*((T/100.))**7
RETURN
END

```

```

SUBROUTINE VAPORE(T,EE)          SUB5   1
C
C
C
C
C
C THIS SUBROUTINE COMPUTES INTERNAL ENERGY OF THE SATURATED VAPOR
C AS A FUNCTION OF TEMPERATURE BASED ON TABULATED DATA FOUND IN
C THERMODYNAMIC PROPERTIES OF STEAM BY KEENAN AND KEYES.          SUB5   5
C
IF(T=164.27)100,110,110          SUB5   6
100 A=1010.0200        SUB5   7
B=44.151063          SUB5   8
C=-47.927376          SUB5   9
D=109.12163          SUB5  10
E=-143.23833         SUB5  11
F=106.95271          SUB5  12
G=-42.224407         SUB5  13
H=6.8214426          SUB5  14
GO TO 260                  SUB5  15
                                         SUB5  16
                                         SUB5  17

```

110	IF(T=260,115)120,130,130	SUB5	18
120	A=926.03611	SUB5	19
	B=278.14603	SUB5	20
	C=-259.10661	SUB5	21
	D=103.45321	SUB5	22
	E=12.916364	SUB5	23
	F=-25.264003	SUB5	24
	G=7.9769554	SUB5	25
	H=-.84472182	SUB5	26
	GO TO 260	SUB5	27
130	IF(T=304.355)140,150,150	SUB5	28
140	A=1152.4271	SUB5	29
	B=-58.084969	SUB5	30
	C=-15.087645	SUB5	31
	D=10.993959	SUB5	32
	E=4.9440762	SUB5	33
	F=-2.1177416	SUB5	34
	G=-.098319244	SUB5	35
	H=.066820631	SUB5	36
	GO TO 260	SUB5	37
150	IF(T=333.08)160,170,170	SUB5	38
160	A=1062.4706	SUB5	39
	B=39.694012	SUB5	40
	C=-26.715969	SUB5	41
	D=2.5549277	SUB5	42
	E=2.8504324	SUB5	43
	F=-.35698700	SUB5	44
	G=-.14969745	SUB5	45
	H=.024931529	SUB5	46
	GO TO 260	SUB5	47
170	IF(T=354.94)180,190,190	SUB5	48
180	A=715.17473	SUB5	49
	B=312.81716	SUB5	50
	C=-87.151285	SUB5	51
	D=8.5512048	SUB5	52
	E=0.	SUB5	53
	F=0.	SUB5	54
	G=0.	SUB5	55
	H=0.	SUB5	56
	GO TO 260	SUB5	57
190	IF(T=390.825)200,210,210	SUB5	58
200	A=878.55708	SUB5	59
	B=90.498982	SUB5	60
	C=-10.289539	SUB5	61
	D=17.958022	SUB5	62
	E=-11.034624	SUB5	63
	F=2.3748115	SUB5	64
	G=-.17490716	SUB5	65
	H=0.	SUB5	66
	GO TO 260	SUB5	67
210	IF(T=469.04)220,230,230	SUB5	68
220	A=645.25487	SUB5	69
	B=165.77474	SUB5	70
	C=24.554849	SUB5	71
	D=-.89322312	SUB5	72
	E=-8.2058582	SUB5	73
	F=2.2156571	SUB5	74
	G=-.17004473	SUB5	75
	H=0.	SUB5	76
	GO TO 260	SUB5	77

230 IF(T=609.025)240,250,250	SUB5	78
240 A=571.63972	SUB5	79
B=288.28337	SUB5	80
C=-27.37626	SUB5	81
D=-10.211310	SUB5	82
E=2.5828531	SUB5	83
F=-.17595317	SUB5	84
G=0.	SUB5	85
H=0.	SUB5	86
GO TO 260	SUB5	87
250 A=-108657.69	SUB5	88
B=35268.016	SUB5	89
C=714.75094	SUB5	90
D=-378.59380	SUB5	91
E=-288.21257	SUB5	92
F=63.134372	SUB5	93
G=-3.4981246	SUB5	94
H=0.	SUB5	95
260 EE=A+B*((T/100.)**2)+C*((T/100.)**3)+D*((T/100.)**4)	SUB5	96
X+F*((T/100.)**5)+G*((T/100.)**6)+H*((T/100.)**7)	SUB5	97
RETURN	SUB5	98
END	SUB5	99

C	SUBROUTINE VATERT(EE,T)	SUB6	1
C	SUBROUTINE VATERT IS LABELLED SUB6.	SUB6	2
C	THIS SUBROUTINE COMPUTES THE TEMPERATURE OF SATURATED LIQUID AS A	SUB6	3
C	FUNCTION OF INTERNAL ENERGY BASED ON TABULATED DATA FOUND IN	SUB6	4
C	THERMODYNAMIC PROPERTIES OF STEAM BY KEENAN AND KEYES.	SUB6	5
C	IF(EE<132.145)100,110,110	SUB6	6
100 A=31.998254	SUB6	7	
B=99.193504	SUB6	8	
C=3.0336469	SUB6	9	
D=-2.9754735	SUB6	10	
E=-2.5921556	SUB6	11	
F=8.2591854	SUB6	12	
G=-6.5430182	SUB6	13	
H=1.7376637	SUB6	14	
GO TO 260	SUB6	15	
110 IF(EE<228.645)120,130,130	SUB6	16	
120 A=45.620983	SUB6	17	
B=62.547417	SUB6	18	
C=40.877889	SUB6	19	
D=-21.853458	SUB6	20	
E=5.7294919	SUB6	21	
F=-.60157904	SUB6	22	
G=0.	SUB6	23	
H=0.	SUB6	24	
GO TO 260	SUB6	25	
130 IF(EE<273.855)140,150,150	SUB6	26	
140 A=66.255662	SUB6	27	
B=64.148140	SUB6	28	
C=2.0729156	SUB6	29	
D=10.170845	SUB6	30	
E=-4.3220915	SUB6	31	
F=.52644344	SUB6	32	
G=0.	SUB6	33	
H=0.	SUB6	34	
GO TO 260	SUB6	35	

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150 IF(EE-303.545)160,170,170
160 A=-38.822910
    B=170.80816
    C=-28.318320
    D=10.639001
    E=-4.7143828
    F=1.1555048
    G=-.10321868
    H=0.
    GO TO 260
170 IF(EE-326.365)180,190,190
180 A=-181.00984
    B=171.78848
    C=53.145240
    D=-14.440502
    E=-5.0170720
    F=-.010539712
    G=.80270495
    H=-.12315288
    GO TO 260
190 IF(EE-364.295)200,210,210
200 A=20.099451
    B=109.77618
    C=-2.1994023
    D=0.
    E=0.
    F=0.
    G=0.
    H=0.
    GO TO 260
210 IF(EE-449.9)220,230,230
220 A=22.515996
    B=74.262170
    C=18.836908
    D=-1.8194331
    E=-.52120460
    F=-.17979319
    G=.094610790
    H=-.0091883440
    GO TO 260
230 IF(EE-622.85)240,250,250
240 A=-139.25712
    B=164.32685
    C=25.885492
    D=-17.219213
    E=2.7625740
    F=-.0079834195
    G=-.035055191
    H=.0023235301
    GO TO 260
250 A=-1863.2696
    B=557.52566
    C=179.13256
    D=-76.038437
    E=7.8719563
    F=.20590038
    G=-.079408469
    H=.0035265412
260 T=A+B*((EE/100.)*C*((EE/100.)*2)+D*((EE/100.)*3)+E*((EE/100.)*4)+F*((EE/100.)*5)+G*((EE/100.)*6)+H*((EE/100.)*7)
    X=F*((EE/100.)*5)+G*((EE/100.)*6)+H*((EE/100.)*7)
    RETURN
    END
    SUB6 38
    SUB6 39
    SUB6 40
    SUB6 41
    SUB6 42
    SUB6 43
    SUB6 44
    SUB6 45
    SUB6 46
    SUB6 47
    SUB6 48
    SUB6 49
    SUB6 50
    SUB6 51
    SUB6 52
    SUB6 53
    SUB6 54
    SUB6 55
    SUB6 56
    SUB6 57
    SUB6 58
    SUB6 59
    SUB6 60
    SUB6 61
    SUB6 62
    SUB6 63
    SUB6 64
    SUB6 65
    SUB6 66
    SUB6 67
    SUB6 68
    SUB6 69
    SUB6 70
    SUB6 71
    SUB6 72
    SUB6 73
    SUB6 74
    SUB6 75
    SUB6 76
    SUB6 77
    SUB6 78
    SUB6 79
    SUB6 80
    SUB6 81
    SUB6 82
    SUB6 83
    SUB6 84
    SUB6 85
    SUB6 86
    SUB6 87
    SUB6 88
    SUB6 89
    SUB6 90
    SUB6 91
    SUB6 92
    SUB6 93
    SUB6 94
    SUB6 95
    SUB6 96
    SUB6 97
    SUB6 98
    SUB6 99

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```

SUBROUTINE GOMTRY(IDENT,NODES,XX,XK,X,C,RHO)
C
C      SUBROUTINE GOMTRY IS LABELLED SUB7.
C
      DIMENSION NN(25),THICK(25),C(25,9),RHO(25,9),XK(25,9),CREG(25),
     XRHOREG(25),XKREG(25),X(25,9),XX(25,9),NODES(9)
1 FORMAT(6I12)                                SUB7  1
2 FORMAT(6E12.5)                               SUB7  2
3 FORMAT(6TH ADDITIONAL IDENTIFYING PARAMETERS OF CONDUCTING SUB-SYSSUB7  3
      XTEM NUMBER ,I2,17H WHICH CONTAINS ,I2,20H CONDUCTING LAYERS ,    SUB7  4
      X12H******/)                                SUB7  5
4 FORMAT(15H LAYER NUMBER ,I9,6I15)             SUB7  6
5 FORMAT(15HOTOTAL NODES ,I9,6I15)              SUB7  7
6 FORMAT(15HOTHICKNESS ,F12.4,6F15.4)           SUB7  8
7 FORMAT(15HDENSITY ,F12.4,6F15.4)              SUB7  9
8 FORMAT(15H0HEAT CAPACITY ,F12.4,6F15.4)       SUB7 10
9 FORMAT(15H0CONDUCTIVITY ,F12.4,6F15.4)        SUB7 11
10 FORMAT(7H0 NODE ,5X,13H DISTANCE ,5X,13HCONDUCTIVITY ,5X,
     X20HTHICKNESS ASSOCIATED,5X,24HHEAT CAPACITY ASSOCIATED,5X,
     X18HDENSITY ASSOCIATED)                      SUB7 12
11 FORMAT(7H NUMBER,5X,13HBETWEEN NODES,5X,13HBETWEEN NODES,5X,
     X20H WITH EACH NODE ,5X,24H WITH EACH NODE ,5X,
     X18H WITH EACH NODE /)                       SUB7 13
12 FORMAT(I5,36X,F21.4,F27.4,F26.4)            SUB7 14
13 FORMAT(4X,2F18.4)                            SUB7 15
14 FORMAT(72H
      X
15 FORMAT(//)
16 FORMAT(1H1)                                 SUB7 16
      PRINT 16
      DO 100 J=1,4
C
C      EACH CONDUCTING SUB-SYSTEM INPUT SET READ IN AND DISPLAYED
      READ 14
      READ 14
100 PRINT 14
      PRINT 15
      READ 1, N,(NN(J),J=1,N)                     SUB7 33
      READ 2, (THICK(J),J=1,N)                     SUB7 34
      READ 2, (RHOREG(J),J=1,N)                    SUB7 35
      READ 2, (CREG(J),J=1,N)                      SUB7 36
      READ 2, (XKREG(J),J=1,N)                     SUB7 37
      PRINT 3, IDENT,N                           SUB7 38
      PRINT 4, (J,J=1,N)                         SUB7 39
      PRINT 5, (NN(J),J=1,N)                      SUB7 40
      PRINT 6, (THICK(J),J=1,N)                    SUB7 41
      PRINT 7, (RHOREG(J),J=1,N)                  SUB7 42
      PRINT 8, (CREG(J),J=1,N)                     SUB7 43
      PRINT 9, (XKREG(J),J=1,N)                   SUB7 44
      PRINT 10
      PRINT 11
C
C      GEOMETRY COMPUTATIONS
      NODES(IDENT)=1                             SUB7 45
      DO 110 I=1,N                               SUB7 46
110 NODES(IDENT)=NODES(IDENT)+NN(I)=1          SUB7 47
      L=1
      M=NN(1)-1
      DO 130 K=1,N
      KK=K+1
      DO 120 I=L,M

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XK(I,IDENT)=XKREG(K)          SUB7 61
120 XX(I,IDENT)=THICK(K)/(NN(K)-1.)  SUB7 62
L=M+1                         SUB7 63
130 M=M+NN(KK)-1               SUB7 64
X(1,IDENT)=.5*THICK(1)/(NN(1)-1.)  SUB7 65
C(1,IDENT)=CREG(1)             SUB7 66
RHO(1,IDENT)=RHOREG(1)         SUB7 67
PRINT 12, 1,X(1,IDENT),C(1,IDENT),RHO(1,IDENT)  SUB7 68
PRINT 13, XX(1,IDENT),XK(1,IDENT)           SUB7 69
L=2                           SUB7 70
M=NN(1)-1                     SUB7 71
DO 160 K=1,N                  SUB7 72
KK=K*1                         SUB7 73
DO 140 I=L,M                  SUB7 74
X(I,IDENT)=THICK(K)/(NN(K)-1.)  SUB7 75
C(I,IDENT)=CREG(K)             SUB7 76
RHO(I,IDENT)=RHOREG(K)         SUB7 77
PRINT 12, I,X(I,IDENT),C(I,IDENT),RHO(I,IDENT)  SUB7 78
PRINT 13, XX(I,IDENT),XK(I,IDENT)           SUB7 79
140 CONTINUE                   SUB7 80
MM=M*1                         SUB7 81
IF(MM-NODES(IDENT))150,170,170  SUB7 82
150 X(MM,IDENT)=0.5*(THICK(K)/(NN(K)-1.)*THICK(KK)/(NN(KK)-1.))  SUB7 83
C(MM,IDENT)=((THICK(K)/(NN(K)-1.))+CREG(K)+(THICK(KK)/(NN(KK)-1.)))  SUB7 84
X*CREG(KK))/(THICK(K)/(NN(K)-1.)*THICK(KK)/(NN(KK)-1.))  SUB7 85
RHO(MM,IDENT)=((THICK(K)/(NN(K)-1.))*RHOREG(K)+(THICK(KK)/(NN(KK)-1.))  SUB7 86
X1.))*RHOREG(KK))/(THICK(K)/(NN(K)-1.)*THICK(KK)/(NN(KK)-1.))  SUB7 87
PRINT 12, MM,X(MM,IDENT),C(MM,IDENT),RHO(MM,IDENT)           SUB7 88
PRINT 13, XX(MM,IDENT),XK(MM,IDENT)           SUB7 89
L=M+2                         SUB7 90
160 M=M+NN(KK)-1               SUB7 91
170 LL=NODES(IDENT)            SUB7 92
X(LL,IDENT)=.5*THICK(N)/(NN(N)-1.)  SUB7 93
C(LL,IDENT)=CREG(N)             SUB7 94
RHO(LL,IDENT)=RHOREG(N)          SUB7 95
PRINT 12, NODES(IDENT),X(LL,IDENT),C(LL,IDENT),RHO(LL,IDENT)  SUB7 96
RETURN                         SUB7 97
END                           SUB7 98

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SUBROUTINE CONDUC(LL,DTAU,N,X,XX,XK,XH1,XHN,C,RHO,TB11,TB12,TB21, SUB8 1
XTB22,T)                      SUB8 2
C
C   SUBROUTINE CONDUC IS LABELLED SUB8,
C
C   THIS SUBROUTINE COMPUTES CONDUCTING SUB-SYSTEM NODAL TEMPERATURES SUB8 3
C   BY SIMULTANEOUS EQUATION SOLUTION.                         SUB8 4
C   DIMENSION T(25,9),A(25,25),B(25,1),C(25,9),RHO(25,9),X(25,9), SUB8 5
XXK(25,9),XX(25,9),N(9),NN(9),XH1(9),XHN(9)                SUB8 6
K=N(LL)                      SUB8 7
KK=K+1                     SUB8 8
A(1,1)=-XH1(LL)-XK(1,LL)/XX(1,LL)-2.*RHO(1,LL)*C(1,LL)*X(1,LL)/ SUB8 9
X(DTAU/3600.)                 SUB8 10
A(1,2)=XK(1,LL)/XX(1,LL)          SUB8 11
DO 100 J=3,K                  SUB8 12
100 A(1,J)=0.                  SUB8 13
B(1,1)=-TB12*XH1(LL)+TB11*(-XH1(LL))+T(1,LL)*(XH1(LL)+XK(1,LL))  SUB8 14
X/XX(1,LL)-2.*RHO(1,LL)*C(1,LL)*X(1,LL)/(DTAU/3600.)          SUB8 15
X=T(2,LL)*XK(1,LL)/XX(1,LL)          SUB8 16
DO 150 M=2,KK                  SUB8 17

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MPLUS1=M+1                      SUB8  21
MM=M=1                          SUB8  22
DO 140 J=M,K                     SUB8  23
IF(J=M-1)120,110,130            SUB8  24
110 A(M,J)=XK(M,LL)/XX(M,LL)    SUB8  25
GO TO 140                        SUB8  26
120 A(M,J)=-XK(MM,LL)/XX(MM,LL)-XK(M,LL)/XX(M,LL)-2.*RHO(M,LL)
   X*C(M,LL)*X(M,LL)/(DTAU/3600.)  SUB8  27
   GO TO 140                      SUB8  28
130 A(M,J)=0.                      SUB8  29
140 CONTINUE                      SUB8  30
140 CONTINUE                      SUB8  31
   B(M,1)=-T(MM,LL)*XK(MM,LL)/XX(MM,LL)+T(M,LL)*(XK(MM,LL)/XX(MM,LL))
   X+XK(M,LL)/XX(M,LL)-2.*RHO(M,LL)*C(M,LL)*X(M,LL)/(DTAU/3600.)  SUB8  32
   X-T(MPLUS1,LL)*XK(M,LL)/XX(M,LL)                      SUB8  33
150 CONTINUE                      SUB8  34
   A(K,K)=-XHN(LL)-XK(KK,LL)/XX(KK,LL)-2.*RHO(K,LL)*C(K,LL)*X(K,LL)
   X/(DTAU/3600.)                  SUB8  35
   B(K,1)=-TB22*XHN(LL)+TB21*(-XHN(LL))+T(<,LL)*(XHN(LL)+XK(KK,LL)
   X/XX(KK,LL)-2.*RHO(K,LL)*C(K,LL)*X(K,LL)/(DTAU/3600.)  SUB8  36
   X-T(KK,LL)*XK(KK,LL)/XX(KK,LL)                      SUB8  37
   CALL GAUSS2(A,K,B)
   DO 160 I=1,K                     SUB8  38
160 T(I,LL)=B(I,1)                SUB8  39
RETURN                           SUB8  40
END                               SUB8  41
                                     SUB8  42
                                     SUB8  43
                                     SUB8  44
                                     SUB8  45

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C
C          SUBROUTINE GAUSS2(ARRAY,N,D)           SUB9  1
C
C          SUBROUTINE GAUSS2 IS LABELLED SUB9.      SUB9  2
C
C          THIS SUBROUTINE SOLVES A TRIDIAGONAL DETERMINANT USING THE METHOD  SUB9  3
C          OF GAUSS.                                SUB9  4
C          DIMENSION ARRAY(25,25),A(25),B(25),C(25),D(25,1),ALPHA(25),S(25)  SUB9  5
C          NN=N=1                                     SUB9  6
C          B(1)=ARRAY(1,1)                            SUB9  7
C          C(1)=-ARRAY(1,2)                          SUB9  8
C          DO 100 I=2,NN                            SUB9  9
C          II=I-1                                  SUB9 10
C          III=I+1                                SUB9 11
C          A(I)=C(II)                             SUB9 12
C          B(I)=ARRAY(I,I)                         SUB9 13
C          C(I)=-ARRAY(I,III)                      SUB9 14
100   C(N)=C(NN)                            SUB9 15
C          A(N)=C(NN)                            SUB9 16
C          B(N)=ARRAY(N,N)                         SUB9 17
C          ALPHA(1)=B(1)                           SUB9 18
C          DO 110 I=2,N                           SUB9 19
C          II=I-1                                  SUB9 20
C          110 ALPHA(I)=B(I)-A(I)*C(II)/ALPHA(II)  SUB9 21
C          S(1)=D(1)                            SUB9 22
C          DO 120 I=2,N                           SUB9 23
C          II=I-1                                  SUB9 24
C          120 S(I)=D(I)+A(I)*S(II)/ALPHA(II)    SUB9 25
C          D(N)=S(N)/ALPHA(N)                      SUB9 26
C          DO 130 I=1,NN                           SUB9 27
C          II=NN-I+1                            SUB9 28
C          III=II+1                            SUB9 29
C          130 D(II)=(S(II)+C(II)*D(III))/ALPHA(II)  SUB9 30
C          RETURN                                 SUB9 31
C          END                                   SUB9 32
                                     SUB9 33

```

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